

508-001
TC-32-120-D3



POWER SUPPLIES UNLIMITED

NJE CORPORATION

Kenilworth, New Jersey

INSTRUCTION MANUAL

TC LINE

SILICON CONTROLLED RECTIFIER

POWER SUPPLIES

SERIAL NUMBER 17962-3
208-001

NJE CORPORATION

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Rev B

1/7/84

WARNING

THIS EQUIPMENT EMPLOYS VOLTAGES WHICH ARE DANGEROUS
AND CAN BE FATAL IF CONTACTED BY OPERATING PERSONNEL.
EXTREME CAUTION MUST BE EXERCISED WHEN WORKING WITH
THIS EQUIPMENT.

INTRODUCTION

DEVIATIONS

This manual covers the Standard NJE power supplies as indicated in Section I herein. Where deviations to the specifications are built into equipment at customer's request, the nature of the deviation as it affects this manual is indicated in a Specification Sheet which precedes Section I. If special schematic drawings, parts placement drawings and spare parts lists are required for the deviation they will be found in Section V of the manual, in place of the Standard material.

CORRESPONDENCE

All correspondence must reference the complete description of the unit as shown on the identification label located at the rear of the unit.

In requesting spare parts or information relative to parts, the Reference Designation, the rating, the description and the NJE Part Number must be specified for each part in question.

DESIGN IMPROVEMENTS

N. J. E. Corporation reserves the right to make design improvements on any instrument without prior notice.

REPRODUCTION

No material, drawings, text, figures or any part of this instruction manual may be reproduced without express written consent of N. J. E. Corporation.

REPAIR SERVICE

N. J. E. Corporation provides complete repair facilities at the main plant and at local service centers as listed on the back of this manual. These repair facilities are adequately staffed with factory trained technicians to assure our customers of the most knowledgeable and expedient servicing of our equipment. All equipment forwarded to these facilities must be adequately packaged to prevent damage in transit.

OUT OF WARRANTY SERVICE:

Forward defective equipment to factory or local service center prepaid. A full description of difficulties encountered or the repair required should accompany this shipment. An estimate of the cost of repair will be submitted to you. The necessary servicing will be performed only upon receipt of your written service orders. Your equipment will be returned to you via collect shipment unless otherwise specified on your service order.

IN WARRANTY SERVICE:

If during the warranty period the power supply indicates an inherent defect, immediately communicate with your nearest NJE Field Representative in your area. If, after examination, he concurs that the unit is defective under the warranty conditions, he will provide written authorization for the return of the unit to the factory or the local field service center, whichever is nearest. N. J. E. Corporation will not assume any transportation charges on incoming equipment without the concurring written approval from its field representative.

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SPECIFICATION

NJE MODEL TC-32-120-D3

NJE PART NO: 82601

1. This is NJE Standard Catalog Model TC-32-120 modified to provide over voltage crowbar set at 35 Volts DC.
2. All other specifications are per NJE Catalog for Model TC-32-120 and any standard catalog options specified on Acknowledgement.

Ref: 105-22557 - JP

NJE DWG. No. 104991
Sheet 1 of 1
1/6/65

SECTION I

SPECIFICATIONS

1.1 GENERAL:

The TC line of Silicon Controlled Rectifier Regulated Power Supplies is designed for use in applications requiring a well regulated and stable source of DC power at high values of current. The specifications herein are tabulated where ratings change from unit to unit (See Table 1-1) and are generalized into paragraphs where ratings are common.

1.2 GENERAL ELECTRICAL SPECIFICATIONS:

1.2.1 Input: See Table 1-1.

1.2.2 Output Voltage and Current: See Table 1-1.

1.2.3 Static Regulation:

1.2.3.1 Load: At constant input voltage, the regulation for load changes is less than 0.25% from half load to full load and less than 0.25% from half load to no load.

1.2.3.2 Line:

1.2.3.2.1 115 Volt Input Models: At constant load, the regulation is less than 0.5% for a line change from 115 Volts to 105 Volts, and less than 0.5% for a line change from 115 Volts to 125 Volts.

1.2.3.2.2 208 Volt Input Models: At constant load, the regulation is less than 0.5% for a line change from 208 volts to plus 10% and less than 0.5%, for a line change from 208 Volts to minus 10%.

1.2.4 Ripple: See Table 1-1.

1.2.5 Transient Response: The output voltage begins its recovery cycle in less than 30 milliseconds for single phase units and less than 10 milliseconds for three phase units.

1.2.6 Meters: Voltmeter and ammeter rated accurate to 2% of full scale value are provided on the front panel.

- 1.2.7 Polarity: The output may be "floated" up to 500V peak above ground. Either polarity may be grounded to chassis by means of terminals provided.
- 1.2.8 Duty: Continuous at ambient temperatures from 0°C to 50°C. Operation above 50°C is allowed provided the output current is derated linearly to zero at 85°C.
- 1.2.9 Remote Sensing: Sensing terminals, separate from the Output terminals, provide sensing and load regulation against the voltage at the load rather than the voltage at the power supply output terminals. This eliminates the otherwise unavoidable load regulation due to the voltage drop in the wires connecting the supply to the load. This feature does not eliminate voltage excursions resulting from load transients through load line impedance.
- 1.2.10 Remote Programming: The output voltage may be controlled accurately from a remote point, if desired by varying the resistance across the REMOTE PROGRAM terminals. The sensitivity of this circuit is indicated on Table 1-1.
- 1.2.11 Dualling: Two or more units may be operated in series to provide higher voltage output at rated current and provided that the cooling requirements of Paragraph 1.3.2 are met.
- 1.2.12 Termination: A barrier type terminal strip at the rear of the unit provides interface connection for input, output, remote sensing, remote programming and ground, except that units with output current above 50 amperes have the output termination by means of threaded studs. Those units which have front panel binding posts for output termination in addition to the output terminals at the rear are indicated in Table 1-1.
- 1.2.13 Protection: Protective fuse will interrupt input power in the event of internal failure.
- 1.2.14 Output Capacitor: Not applicable.
- 1.2.15 Constant Current: All units are converted readily to Current Regulation rather than Voltage Regulation by the addition of an appropriate external sensing resistor.
- 1.2.16 Resolution: Continuously variable single turn potentiometer produces the resolution indicated in Table 1-1.

1.3 MECHANICAL SPECIFICATIONS:

- 1.3.1 Outline Drawing: Table 1-1 indicates which Outline Drawing is applicable to the unit in question.
- 1.3.2 Airflow: Units of panel height less than 7" do not have blowers and depend on conduction and convection for cooling. Units of panel height 7" and greater have internal blowers and depend on forced air cooling in addition to the conduction and convection cooling. Air flow paths as indicated in the appropriate Outline Drawing must not be blocked. Where two or more units are rack-mounted one above the other or where adjacent equipment increase the ambient temperature above the limits specified in Paragraph 1.2.8 above, filler panels of at least 1-3/4" height should be installed above and below the power supplies in question.
- 1.3.3 Mounting: When installed in racks, it is recommended that support angles be provided so that the power supply weight is not supported entirely by the front panel mounting hardware.
- 1.3.4 Finish: Front Panel finished in dark grey enamel equivalent to FED STD 595 chip #26132. Panel marking is white. All other finishes are appropriate paint, plating, or chemical film as required.

1.4 OPTIONAL FEATURES:

Table 1-2 indicates the specific optional features which are available on any given unit. The general description of these optional features follows:

- 1.4.1 Suffix (-50): Extension of the Input frequency range to 47-65 cps. This option requires that the Output current be derated by 1/6 of the maximum rating as specified in Table 1-1.
- 1.4.2 Suffix (-B): Addition of bench adapters.
- 1.4.3 Suffix (-P): Addition of three wire power cord and plug.
- 1.4.4 Suffix (-SF): Non-standard finish to front panel of unit.
 - 1.4.4.1 Where specifying (-SF) option customer must provide NJE the following information:
Color to be used (preferably FED STD 595 chip number).

1.4.4.1 (cont'd)

Color to be used for marking.

Process to be used if other than NJE Standard finish process.

Whether paint is to be supplied by customer or NJE.

- 1.4.5 Suffix (-LV): Output Adjust (-LV) potentiometer and knob replaced by a single turn screwdriver adjust potentiometer with shaftlock.
- 1.4.6 Prefix (E): Deletion of meters.
- 1.4.7 Suffix (-220): Conversion of unit with nominal input voltage of 208 volts to nominal of 220 volts.

NOTE: Example of buildup of final model number for a TC-32-20 without meters and with bench adapter and line cord is as follows:
ETG-32-20-B-P.

NOTE: NJE Corporation invites requests for quotation of special applications which can be accomplished by minor deviation of standard catalog units.

MODEL NO.	OUTPUT (1)		INPUT			RIPPLE RMS(2)	FRONT PANEL OUTPUT	REMOTE PROGRAM SENSITIVITY	RESOLUTION	WEIGHT		OUTLINE DWG.
	VOLTS	AMPS	VOLTS	ϕ (4)	FREQ.					NET	SHIP	
TC-14-15	5-14	0-15	105-125	1	47-65	5	YES	165	75MV	40	65	303369 - 303370
TC-14-30	5-14	0-30	105-125	1	47-65	9	YES	165	75MV	70	90	303373 - 303374
TC-14-200	5-14	0-200	208 $\pm$ 10%	3	55-65	15	NO	165	75MV	295	375	303377 - 303378 303379
TC-32-10	10-32	0-10	105-125	1	47-65	5	YES	180	150MV	40	65	303369 - 303370
TC-32-20	10-32	0-20	105-125	1	47-65	9	YES	180	150MV	70	90	303373 - 303374
TC-32-30	10-32	0-30	105-125	1	47-65	16	YES	180	150MV	90	120	303371 - 303372
TC-32-50	10-32	0-50	208 $\pm$ 10%	1	55-65	14	NO	180	150MV	160	190	103974 - 303376 303375
TC-32-120	10-32	0-120	208 $\pm$ 10%	3	55-65	15	NO	180	150MV	295	375	303377 - 303378 303379
TC-52-6	20-52	0-6	105-125	1	47-65	5	YES	155	200MV	40	65	303369 - 303370
TC-52-12	20-52	0-12	105-125	1	47-65	9	YES	155	200MV	70	90	303373 - 303374
TC-52-30	20-52	0-30	208 $\pm$ 10%	1	55-65	13	NO	155	200MV	160	190	103974 - 303376 303375
TC-80-4	25-80	0-4	105-125	1	47-65	5	YES	180	450MV	40	65	303369 303370
TC-80-8	25-80	0-8	105-125	1	47-65	9	YES	180	450MV	70	90	303373 - 303374
TC-80-20	25-80	0-20	208 $\pm$ 10%	1	55-65	13	YES ~~NO~~	180	450MV	160	190	103974 - 303376 303375
TC-100-6	40-100	0-6	105-125	1	47-65	9	YES	165	450MV	70	90	303373 - 303374

NOTES:

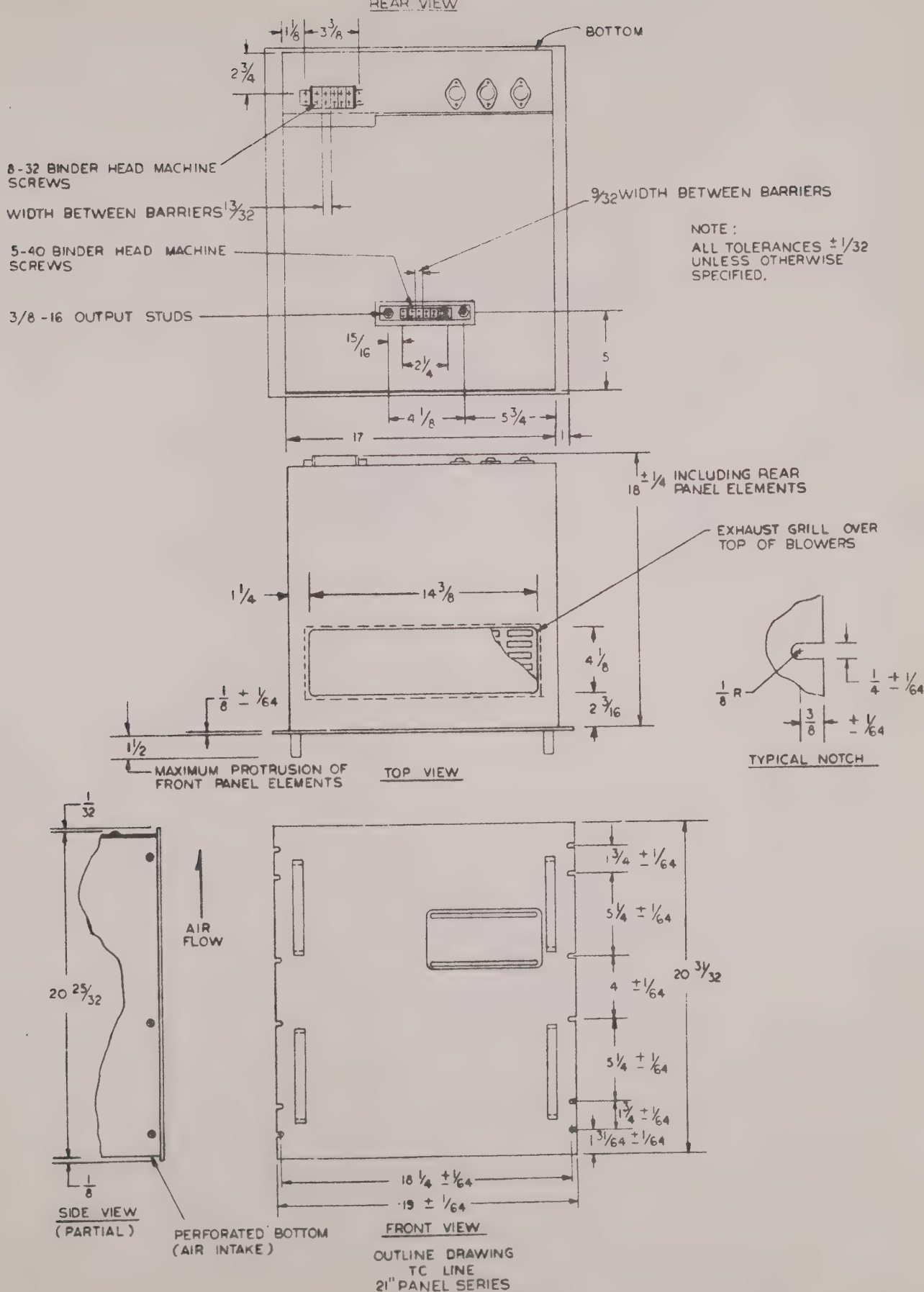
- (1) OUTPUT VOLTAGE MAY BE INCREASED TO 120% OF MAXIMUM RATING PROVIDED OUTPUT CURRENT IS DERATED LINEARLY TO ZERO AT 120% OF MAXIMUM OUTPUT VOLTAGE RATING.
- (2) RIPPLE SPECIFIED ABOVE IS APPLICABLE TO 60 CPS OPERATION AT FROM 80% TO 100% OF FULL RATED VOLTAGE. INCREASE RIPPLE LINEARLY TO 1.5 TIMES ABOVE FIGURE AT MINIMUM OUTPUT VOLTAGE. UNITS WHICH HAVE INPUT FREQUENCY RANGE OF FROM 47-65 CPS HAVE A RIPPLE 1.5 TIMES VALUE SPECIFIED ABOVE AT 50 CPS.
- (3) APPROXIMATE SENSITIVITY SPECIFIED ABOVE IS IN OHMS PER VOLT ABOVE THE MINIMUM OUTPUT VOLTAGE AND WITHIN THE VOLTAGE RANGE SPECIFIED.
- (4) 3 ϕ UNITS REQUIRE 4 WIRE SYSTEM WITH NEUTRAL.

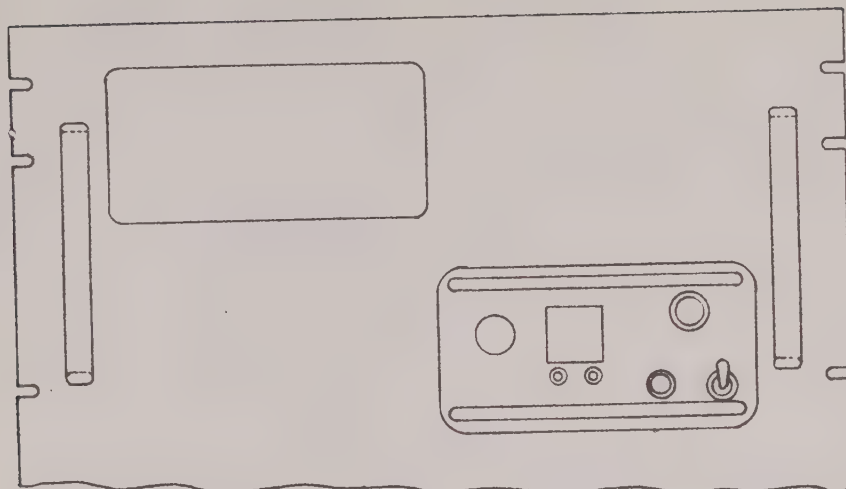
TABLE I-1
TABULATED SPECIFICATIONS

MODEL NO.	OPTION						
	(-50)	(-B)	(-P)	(-SF)	(-LV)	(-220)	(E)
TC-14-15		X	X	X	X		X
TC-14-30		X	X	X	X		X
TC-14-200	X			X	X		X
TC-32-10		X	X	X	X		X
TC-32-20		X	X	X	X		X
TC-32-30		X		X	X		X
TC-32-50	X			X	X	X	X
TC-32-120	X			X	X		X
TC-52-6		X	X	X	X		X
TC-52-12		X	X	X	X		X
TC-52-30	X			X	X	X	X
TC-80-4		X	X	X	X		X
TC-80-8		X	X	X	X		X
TC-80-20	X			X	X	X	X
TC-100-6		X	X	X	X		X

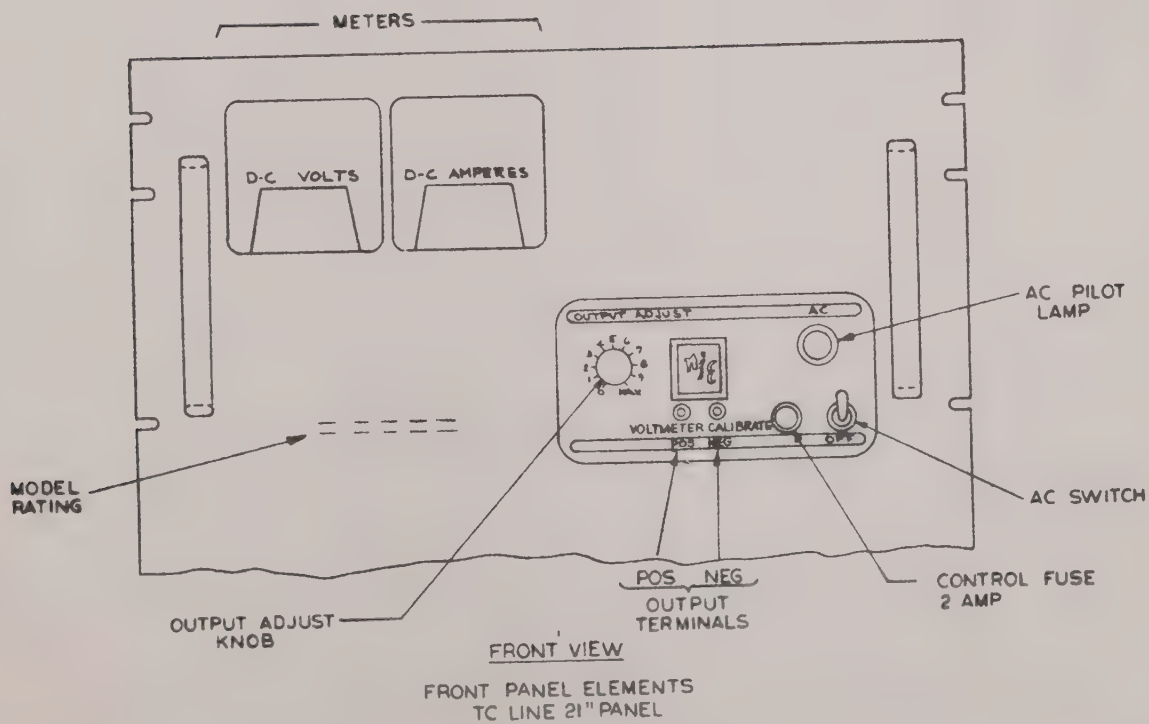
X MEANS OPTION AVAILABLE

TABLE I-2
OPTION LIST



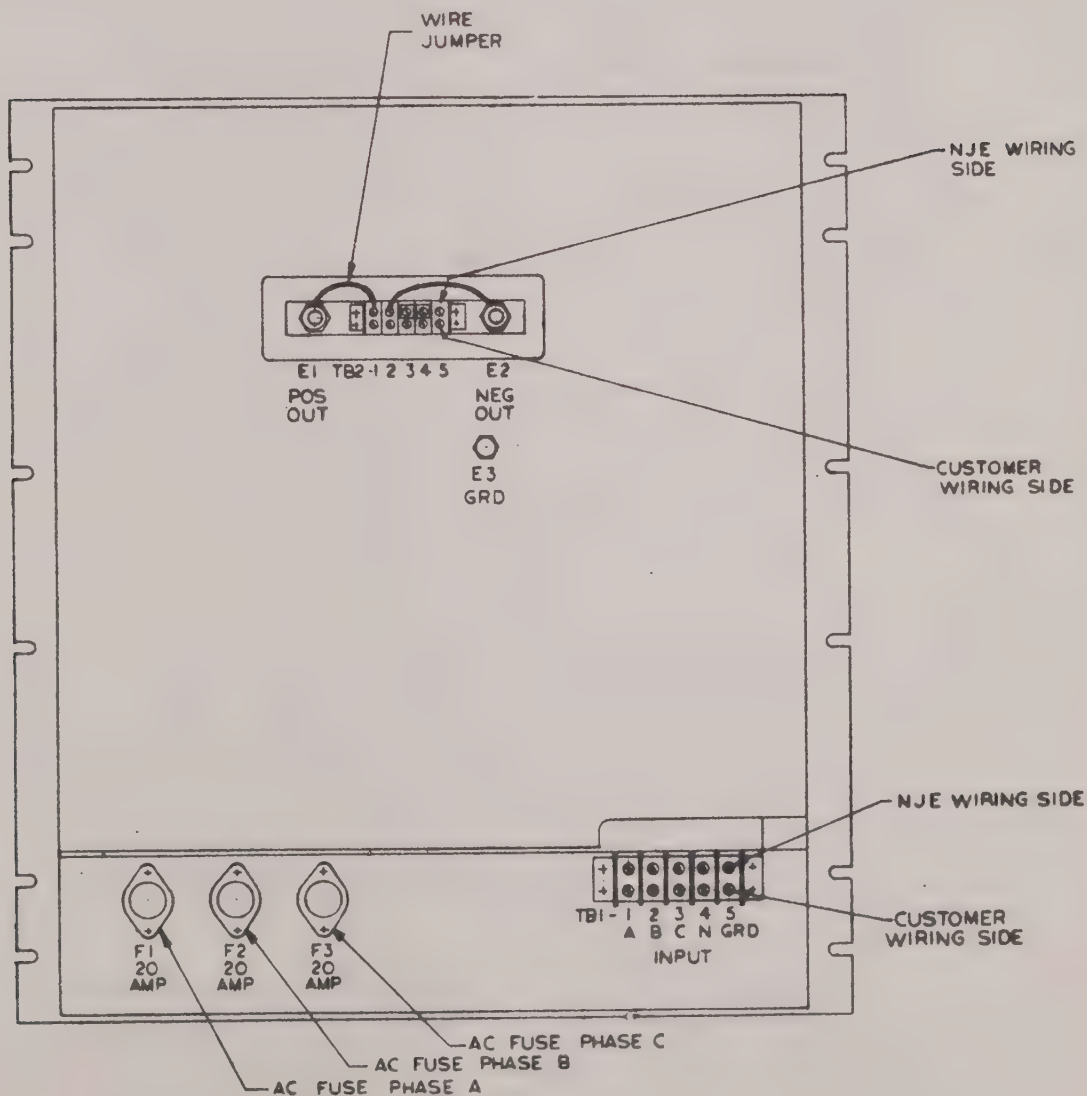


FRONT VIEW
NON-METERED FRONT PANEL ELEMENTS
OPTION (E-)



TERM NO	SCREENED FUNCTION	RECOM'D WIRE SIZE	REMARKS
TB1-1	A	NO 12 AWG	AC INPUT PHASE A
2	B	NO 12 AWG	AC INPUT PHASE B
3	C	NO 12 AWG	AC INPUT PHASE C
4	N	NO 12 AWG	AC INPUT NEUTRAL
5	GRD	NO 12 AWG	AC INPUT GROUND
TB2-1	POS SENS	NO 20 AWG	NORMALLY JUMPED TO POS OUT 1
2	NEG SENS	NO 20 AWG	NORMALLY JUMPED TO NEG OUT 1
3	REMOTE	NO 20 AWG	NORMALLY JUMPED TOGETHER 1
4	PROGRAM	TWISTED PR	
5	GRD		SENSING GROUND 2
E1	POS OUT	NO 0 AWG	POS OUTPUT STUD
E2	NEG OUT	NO 0 AWG	NEG OUTPUT STUD
E3	GRD	NO 0 AWG	DC GROUND STUD

1. TWISTED PAIR WHERE USED
2. USED WHERE SHIELDED WIRE IS USED FOR SENSING LEADS



REAR VIEW

REAR PLATE ELEMENTS
21" PANEL SERIES

SECTION 11

INSTALLATION AND OPERATION

2.1 UNPACKING. The power supply is shipped in a corrugated carton which is floated on sufficient insulation in a heavy-duty shipping carton. Aside from normal precaution against damage to the unit in opening the cartons and removing the unit, no special procedures are required. The carton should be opened immediately upon receipt and the contents inspected for shipping damage. The Power Supply was checked electrically and mechanically before it left the factory, and is warranted to be in perfect operating condition. This warranty does not cover possible damage incurred during shipment. Therefore, any evidence of mishandling, such as broken, deformed or missing parts, should be brought to the attention of the transportation company and a claim should be entered. Remove top cover plate and inspect all components and wiring, both on the chassis and panel, as well as the mechanical condition of the housing. The literature packed with the supply should be removed and held for reference in operating the equipment.

2.2 INSTALLATION: Refer to Table 1-1. which indicates which Outline Drawing is to be followed for the model in question. This Outline Drawing shows mounting dimensions, air flow requirements, interface wiring information and other data pertinent to proper installation. Careful observance of All the specification requirements in Section 1 is essential to a proper installation. READ THE SPECIFICATIONS CAREFULLY BEFORE PROCEEDING.

When the unit has been properly placed in position or mounted in its rack and secured in place by the panel screws, electrical connections should be made in accordance with the following step-by-step procedure. Wire sizes to be used and the terminal locations are specified on the appropriate Outline Drawing of Section 1-3. Terminal functions listed in the following instructions are clearly screened on the equipment itself, as well as being indicated on both the outline of Section 1-3 and the schematic drawing of Section 5.

2.3 STANDARD SINGLE UNIT ELECTRICAL INSTALLATION.

2.3.1 Output Grounding: Connect either the positive (POS OUT) or negative (NEG OUT) DC output terminal of the supply (depending upon desired output polarity) directly to the chassis ground terminal (GRD) at the barrier strip on the rear of the chassis, and connect the ground terminal to the system ground.

NOTE: If it is necessary that the power supply circuit float above or below ground, it is recommended that the output terminal should be connected to the chassis ground terminal by a 0.1 microfarad 600 VDC capacitor in place of the direct connection. Use of this by-pass capacitor will improve the stability of the circuit in the ungrounded condition, and reduce the effect of external interference and hum. Refer to Polarity Specification in Section 1 for maximum limitation on floating voltage permitted.

2.3.2 Output Connection: Connect the positive and negative output terminals (POS OUT) and (NEG OUT), respectively to the corresponding terminals of the external load. Use heavier gauge wire than that specified if long distances to the load are involved.

2.3.3 REMOTE SENSING: All units are shipped from the factory with the REMOTE SENSING feature jumpered out on the inter-connection terminal board as follows: (POS SENS) connected to (POS OUT) and (NEG SENS) connected to (NEG OUT). With this connection, the regulation specifications are met ONLY at the output terminals of the supply. If it is desired to have accurate regulation at the remote load point, rather than at the output terminals, proceed as follows:

Connect the output terminals to the load per Paragraph 2.3.2 above. Remove the Jumpers from (POS SENS) to (POS OUT) and (NEG SENS) to (NEG OUT) respectively. Observing correct polarity, run a twisted pair of No. 20 AWG wire (or larger) from (POS SENS) to the positive load point and from (NEG SENS) to the negative load point.

WARNING: DO NOT OPERATE POWER SUPPLY WITHOUT THE SENSING LEADS CONNECTED EITHER REMOTELY OR LOCALLY. MOST CUSTOMER COMPLAINTS OF POOR OPERATION ARE DUE TO IMPROPER SENSING LEAD CONNECTION.

WHEN THE POINT OF REMOTE SENSING IS MORE THAN 10 FEET FROM THE POWER SUPPLY, OSCILLATIONS MAY DEVELOP. A POSSIBLE CURE IS TO CONNECT REMOTE CAPACITANCE AS DESCRIBED IN PARAGRAPH 2.3.4 AND AS CLOSE TO THE POINT OF SENSING AS IS PHYSICALLY POSSIBLE.

2.3.4 Output Capacitor Connections: This feature is not provided on all units. When included in the equipment, the terminals are listed as (POS CAP) and (NEG CAP) on the Outline Drawing. The power supply has been shipped from the factory with the appropriate filter capacitors connected to the appropriate output terminals at the interconnection terminal board. This arrangement is satisfactory for most applications. However, if better transient and dynamic characteristics are required, further improvement can be effected by using an independent capacitor mounted as close to the ultimate load as is practical.

The capacitor used should have the same voltage rating of the power supply output capacitance (see the schematic drawing for the rating of the capacitor connected to the Pos Cap and Neg Cap terminals) and at least the same capacitance rating should be used. Additional capacitors may be ordered by specifying the NJE Part Number of the output capacitor from the Spare Parts List of Section 5.

Reconnections are made as follows: Remove the jumper connection provided between (Pos Out) and (Pos Cap) and between (Neg Out) and (Neg Cap). The load leads should be connected as in paragraph 2.3.2 above. Connect the new capacitor directly at the load being careful to observe polarity. In order to make this connection effective, it will be necessary to utilize the Remote Sensing Connections described in paragraph 2.3.3 above.

2.3.5

REMOTE PROGRAM: To utilize the Remote Programming feature of the unit, remove the jumper across the REMOTE PROGRAM terminals and connect a resistor across the REMOTE PROGRAM terminals. If the resistor is to be located remotely from the power supply, a pair of No. 20 AWG twisted wires should be used. The resistance (R) of the remote program resistor may be calculated as follows:

$$R = (\alpha/V) (V_o - V_{\min}) \text{ ohms}$$

Where (R) is the desired resistance, (α/V) is the Remote Programming sensitivity from Section 1. (V_o) is the desired output voltage and ($V_{\min}$) is the minimum voltage allowed for the power supply as specified in Section 1.

When using this connection the OUTPUT ADJUST potentiometer should be set to zero (extreme counter clockwise position).

WARNING: DO NOT OPERATE THE POWER SUPPLY WITH THE "REMOTE PROGRAM" TERMINALS OPEN CIRCUITED.

2.3.6

INPUT CONNECTION:

2.3.6.1

Single Phase Units: Referring to the correct Outline Drawing as indicated by Table 1-1, connect the proper wire size specified to the two AC terminals, observing the "high" and "return" leads must be wired to the correct terminals. The system ground is connected to the GRD terminals associated with the AC input terminals.

2.3.6.2 Three Phase Units: All units which are specified in Table 1-1 as "208 volts, three phase", are intended to be used with a four wire system with the neutral connected. The outline Drawing indicated in Table 1-1 indicates the correct wire sizes to be used in wiring to the Phase A, Phase B, Phase C and Neutral terminals. In addition, the system ground must be connected to the GRD terminal associated with the AC input terminals. For those units where Table 1-1 specifies input of 460 volts three phase or 220 volts 3 phase 3 wire, the system is a three wire system with no neutral. The connection is similar to that of the four wire system except that no neutral lead is required.

2.3.7 CONSTANT CURRENT CONNECTION: Where specified in Section I, some NJE Power Supplies may be converted to Constant Current Regulated supplies. Figure 2-1 provides information for making this reconnection. Since there are numerous possibilities and parameters which must be considered, the information provided must of necessity be limited. For special applications, consult the factory Application Engineering Department.

On those units equipped with variable current limiting overload protection (See Section I), and where regulation requirements are restricted, Constant Current applications may be achieved directly without resorting to the more refined connection of Figure 2-1. This method of operation is described in Section 2-5.

2.4 Dualling:

2.4.1

COOLING OF DUAL UNIT INSTALLATION: Where the dual units are to be rack mounted one directly above the other, the filler panels referred to in Air Flow specification per paragraph 1.3.2 must be used. These panels may be ordered from NJE Corporation if the same finish is desired. For standard finish, 1-3/4 by 19" filler panels, order NJE Part Number 22164.

2.4.2

SERIES CONNECTION: Those NJE Power Supplies which may be connected in series, as indicated by the Dualling specification in Section I can be so connected using Figure 2-2A. IF "S" option is required, the unit should be ordered specifying the "S" option. Where field connection is required, reverse voltage protection diodes must be installed to protect against reverse voltage during a short circuit on the series connected supplies.

These diodes should have a Forward Average Current rating equal or greater than the output current rating of the supply and a Peak Inverse Voltage rating greater than the highest operating voltage of the application. The diodes must be connected in the nonconducting direction across the power supply output terminals. The series connection is quite straight forward and is essentially the same as connecting two batteries in series. Each supply is independently controlled and delivers an output voltage within its own capability. The total output voltage is, of course, the sum of that of the two supplies.

Connection of the series option, including the location of the reverse voltage protection diodes, is clearly shown in Figure 2-2A. The connection of the sensing leads is for the remote sensing mode of operation. If precise regulation at the load is not required, the sensing leads may be left jumpered at the respective output terminals as in paragraph 2.3.3.

- 2.4.3 **PARALLEL CONNECTION:** Those NJE Power Supplies which may be connected in parallel, as indicated by the Dualling Specification in Section 1, can be connected in parallel using Figure 2-2B. The total paralleled current must be derated by 10% from the individual current rating as the two supplies cannot be made to divide the load exactly.

2.5 OPERATION

- 2.5.1 The following check list should be followed before making the unit operational:
- 2.5.1.1 AC power switch in the OFF position
 - 2.5.1.2 VOLTAGE ADJUST potentiometer in the extreme counter clockwise position
 - 2.5.1.3 CURRENT CONTROL potentiometer (where provided) in the extreme clockwise position
 - 2.5.1.4 Input wiring made per paragraph 2.3.6
 - 2.5.1.5 Output Grounding wired per paragraph 2.3.1
 - 2.5.1.6 Output wiring made per paragraph 2.3.2
 - 2.5.1.7 Remote Sensing wiring made per paragraph 2.3.3
 - 2.5.1.8 Output Capacitor wiring (where provided) made per paragraph 2.3.4
 - 2.5.1.9 Remote Programming wiring made per paragraph 2.3.5
 - 2.5.1.10 Constant Current wiring (where provided) made per paragraph 2.3.7

2.5.1.11 Dualling connection (where desired) made per paragraph 2.4

2.5.2 Step by step operation based on the location of controls as indicated on the Outline Drawing specified in Table 1-1:

2.5.2.1 Energize the AC line

2.5.2.2 Operate the AC power switch to the On Position. The pilot lamp should lite.

2.5.2.3 While monitoring both output voltage and current, slowly rotate the VOLTAGE ADJUST potentiometer clockwise until the desired voltage level is reached.

2.5.2.3.1 If the desired voltage and/or current level (within the ratings of the unit) cannot be reached, de-energize the AC line and recheck all connections per paragraph 2.5.1 above. If still unable to achieve the desired levels, refer to the Trouble Shooting section at the rear of the Manual.

2.5.2.4 CURRENT CONTROL (where provided) may be set to the desired level as follows:

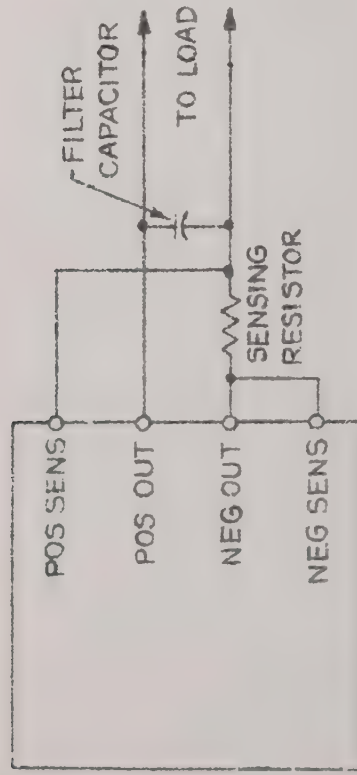
2.5.2.4.1 Method #1: While monitoring the load current, apply a short circuit across the load and rotate the CURRENT CONTROL potentiometer counter clockwise until the desired current level is reached.

2.5.2.4.2 Method #2: While monitoring the load voltage and current, adjust the load so that the desired levels are reached. Rotate the CURRENT CONTROL potentiometer slowly counter clockwise until the current level begins to fall off. A slight clockwise turn of the CURRENT CONTROL will then set the current limiting action just above the Operating level.

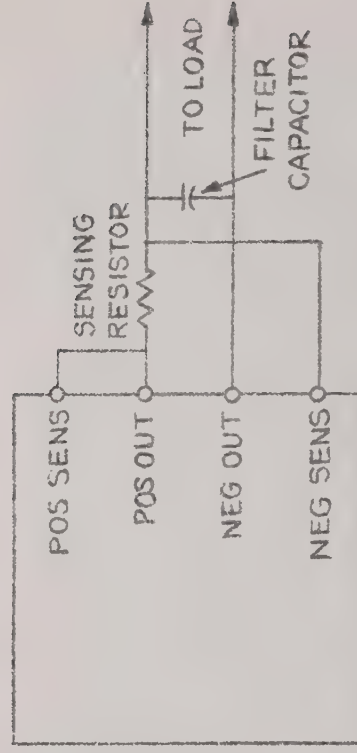
2.5.2.4.3 Method #3: Leaving the CURRENT CONTROL at the extreme clockwise position sets the current limiting action at approximately 110% of the maximum current rating of the supply.

NOTE 1: The current limiting feature is essentially a constant current device. As the load resistance is reduced toward an eventual short circuit condition, the load current will be limited to the preset CURRENT CONTROL setting, and it will hold at this value as the output voltage falls toward zero. The current regulation is better than 5% as the load resistance varies to cause a full swing of output voltage and is proportionally better for smaller load resistance changes.

NOTE 2: For the RVC and the RB Lines, which are provided with both voltage and current regulation with automatic crossover circuitry, the current limiting characteristic described above is highly regulated. Actual current regulation parameters are in accordance with the specifications noted in Section 1.



ALL UNITS EXCEPT TC LINE



TC LINE ONLY

PROCEDURE

1. SENSING RESISTOR SHOULD BE SELECTED TO PRODUCE APPROXIMATELY 1 VOLT DROP AT MAXIMUM DESIRED CONSTANT CURRENT. RESISTOR WATTAGE SHOULD BE AT LEAST FOUR TIMES MAXIMUM DISSIPATION FOR CURRENT STABILITY. SEE NOTE 4.
2. FILTER CAPACITOR SHOULD BE 6-10 MICROFARADS, OIL OR TANTALYTIC, WITH VOLTAGE RATING GREATER THAN MAXIMUM DESIRED OUTPUT VOLTAGE.

NOTE 1: SEE OUTLINE DRAWING, SECTION I, FOR TERMINAL CONNECTIONS AND WIRE SIZES.

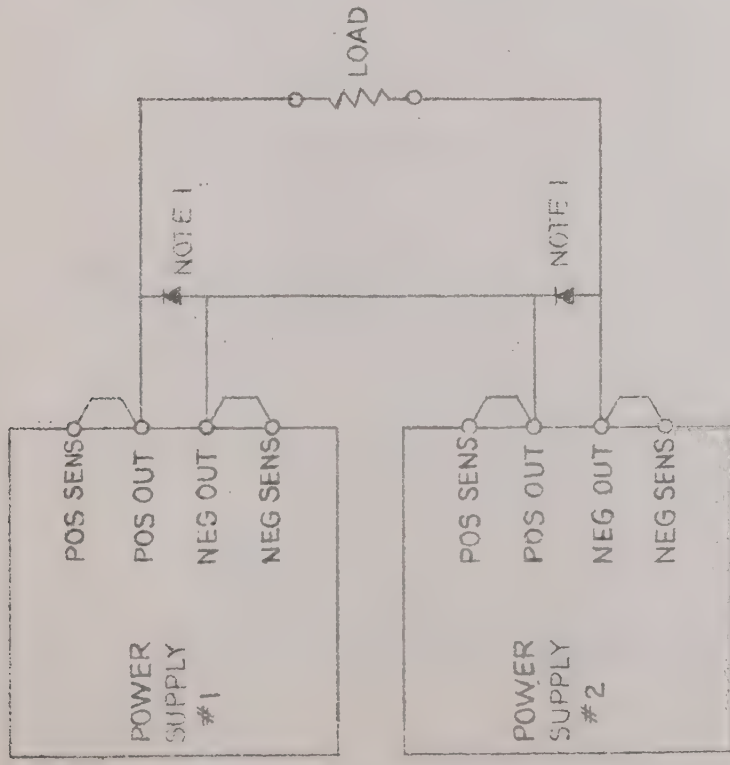
NOTE 2: ON TC UNITS, AN INTERNAL JUMPER BETWEEN TERMINALS 6 AND 11 ON PRINTED CIRCUIT BOARD A2(96PC) MUST BE ADDED FOR CONSTANT CURRENT OPERATION.

NOTE 3: A POTENTIOMETER APPROXIMATELY 10% OF THE RESISTANCE OF THE OUTPUT ADJUST POTENTIOMETER SHOULD BE INSERTED IN THE PROGRAMMING TERMINALS. THE OUTPUT ADJUST SHOULD BE SET TO ITS MINIMUM POSITION. THE NEW POTENTIOMETER WILL THEN PROVIDE CURRENT CONTROL OVER THE DESIRED RANGE. IF DESIRED, THE OUTPUT ADJUST ITSELF MAY BE USED FOR CURRENT CONTROL, BUT ONLY THE LOWEST PORTION OF THE POTENTIOMETER IS USED. IF AVAILABLE ON THE SUPPLY, THE FINE CONTROL CAN PROVIDE ADEQUATE RESOLUTION.

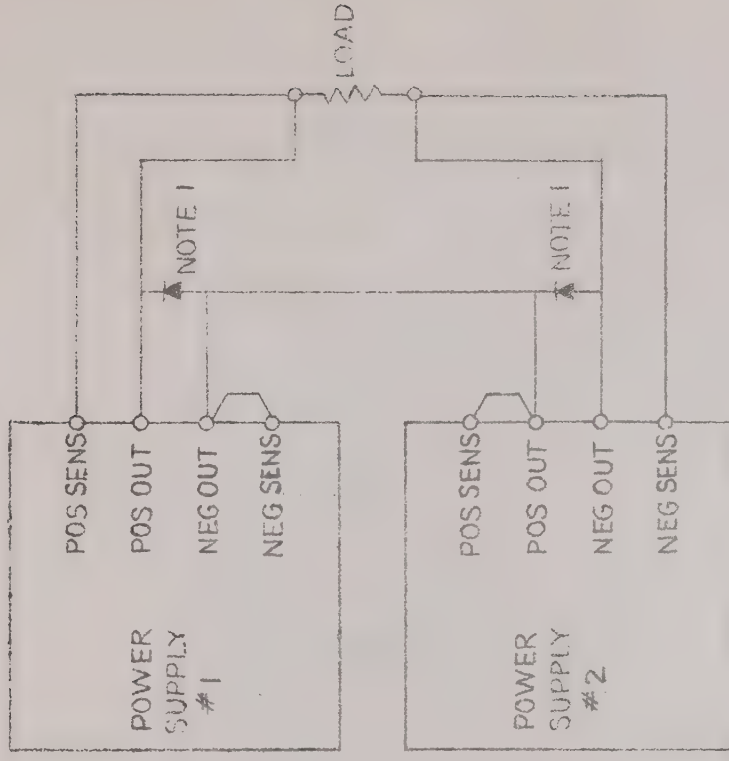
NOTE 4: LOW TEMPERATURE COEFFICIENT RESISTORS WILL IMPROVE STABILITY.

CONSTANT CURRENT CONNECTION

FIG. 2-1



LOCAL SENSING

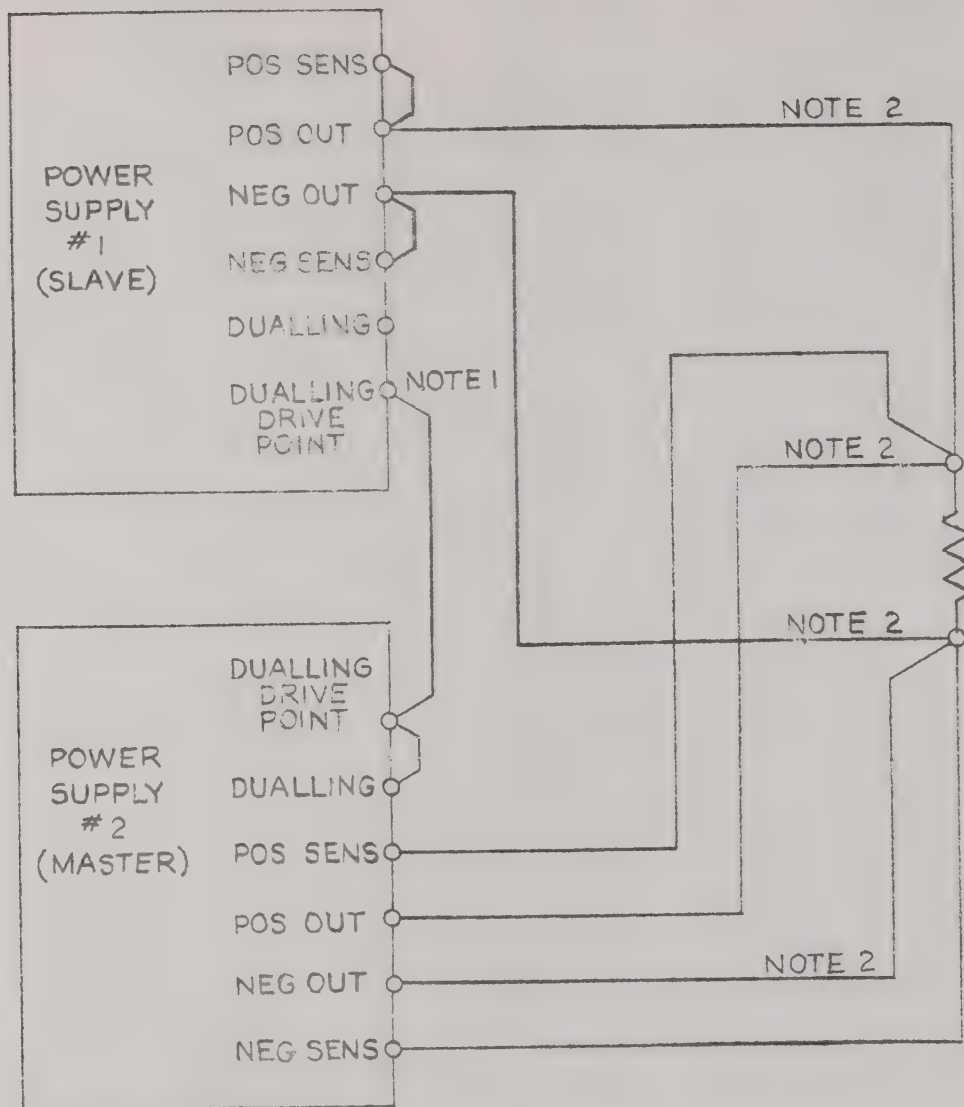


REMOTE SENSING

NOTE 1: REVERSE VOLTAGE DIODE, AS REQ'D. SEE PARA. 2.4.2
SEE OUTLINE DRAWING, SECTION I, FOR TERMINAL
CONNECTIONS AND WIRE SIZES.

SERIES CONNECTION

FIG. 2-2A



NOTE 1: JUMPER REMOVED FROM DUALING TERMINALS ON "SLAVE" UNIT. INTERCONNECT DUALING DRIVE POINTS BETWEEN "MASTER" AND "SLAVE" UNIT. SEE OUTLINE DRAWING, SECTION I, FOR TERMINAL CONNECTION AND WIRE SIZES, INCLUDING DRIVE POINT.

NOTE 2: LOAD LINE RESISTANCES SHOULD BE BALANCED CLOSELY FOR OPTIMUM OPERATION.

PARALLEL CONNECTION

FIG. 2-2B

SECTION III

THEORY OF OPERATION

GENERAL.

Main Supply:

Refer to Figures 3-1 and 5-1

- 3.1 The power is applied to the input control circuit which establishes the unit operationally and the AC is stepped down by transformer (T1) to the appropriate voltage level. This transformer has two secondary windings, namely, a main and an auxiliary. High power units use two separate transformers, and three-phase units utilize three auxiliary transformers. At this point, we are interested in the main secondary.

The semiconductor devices (CR1 to CR4) are arranged in a basic bridge configuration. The SCR's (CR1 and CR4) can be considered as On-Off switching elements of the bridge whose condition at any instant is determined by the line and/or load requirements. For three-phase models, six SCR's (CR1 through CR6) are used in a three phase rectifier configuration.

The pulsating output of the bridge is applied to a familiar smoothing circuit composed of inductor (L1) and capacitor (C1). The diode (CR5) prevents any tendency towards instability that may occur as the output current is lowered and the "value of critical inductance" becomes apparent. In the three-phase models, the filter network consists of (L1), (L2), and (A2C1). The diodes (CR1, CR2) are stabilization elements.

The diodes (A1CR8 and A1CR9) and resistor (A1R9 and A1R10) combination across the SCR (gate to anode) are transient voltage suppressors for the controlled silicon rectifiers (CR1 and CR4). Three sets of these components effect a similar function in the three-phase models. The resistor (R1) is used to preload the unit at all times, thus aiding the stability.

The error sensing amplifier PC board has elements brought out to the positive and negative legs of the supply. The combination of resistors (R2 and A2R19) form part of the divider used for sampling the error and the capacitor (A2C6) is used to shunt any rapid load changes around the resistors in order to speed up the required changes. The capacitor (C4) provides additional filtering for the secondary circuit supply. For the three-phase models, the divider consists of (A1R1) and (A2A4R14). (A2A4C6) is the feedback capacitor. (A2C3) provides the additional supply filtering.

The variable resistor (R17) and capacitor (C4) are part of the active feedback network of the error sensing amplifier 96 PC board. Its principal use is for oscillation suppression especially in the low frequency region, and is set at the factory for optimum operating conditions. To the 95PCboard circuitry senses the error that appears across supply output and provides correcting information to the 95PC board. The 95PC board in turn controls the conduction time of the SCR required to return the supply to the desired level. For the three-phase models, (A2R1, R2 and R3) form part of the matrix circuit for providing proper controlling pulses to each of three trigger amplifiers (95PC).

3.2 DETAILED CIRCUIT DESCRIPTION OF THE 96PC BOARD: Refer to the schematic diagram at the rear of this manual.

3.2.1 Secondary Regulator: A means must be provided for deriving a constant current source for the reference diode (CR1) and this is accomplished as follows:

The error sensing resistor divider consisting of (R5) and (R13) is used by the secondary regulator consisting of transistors (Q2, Q4 and Q5) for sampling line and/or load changes.

The base of transistor (Q4) is driven by the error-difference while the base of transistor (Q2) is held constant by virtue of the reference diode (CR1). This difference is amplified by transistor (Q2) and applied to the base of the series regulator transistor (Q5). The main advantage gained from this NPN to PNP arrangement of the transistor (Q2) and Q4) is complementary compensation against drifting due to temperature changes.

The collector load of the transistor (Q5) is the stabilized source required for the reference diode (CR1).

3.2.2 Error Amplifier: The base of transistor (Q6) is arranged to sense the error difference between the reference voltage developed across the breakdown diode (CR1) and the sampled voltage derived from the divider string resistors (R10, R14, R19 and the OUTPUT ADJUST potentiometer). The error-difference is amplified and applied to the base of the emitter follower transistor (Q3). This arrangement transforms the error-difference to a relatively low source impedance for practical application by the discharge transistor (Q2) on the 95 PC board. The resistors (R2 and R3) are the output load elements for the transistor (Q3 and Q6). The resistor (R11) inserted in the base of transistor (Q6) is primarily used to adjust the gain of the error amplifier and at the same time this aids in stabilizing the circuit. The capacitor (C3) is used to suppress any tendency toward high frequency oscillation in this part of the circuitry.

Another refinement added to the error-difference circuit is the active degenerative feedback network consisting of the transistor (Q1) capacitor (C4) and variable resistor (R17) placed in the feedback loop of the transistor (Q6) base and collector.

The feedback transistor (Q1) is an emitter follower arrangement in order to provide a low source impedance. The resistor (R1) is the output load resistor for developing the required feedback power which is practically decoupled from the driving source transistor (Q6).

- 3.2.3 Turn On Overshoot Suppression: The network consisting of transistor (Q7), capacitor (C2) resistors (R7, R9 and R15) is designed to minimize the output voltage overshoot whenever the power supply is initially energized and in addition it tends to reduce the peak in-rush currents.

For a very short interval after the AC ON switch (S1) is energized the uncharged capacitor (C2) appears as a virtual short-circuit element across the base to collector of the transistor (Q7). This transitory condition places the emitter element of the transistor (Q7) potentially very close to the collector. From this emitter (Q7) point, the base of the discharge transistor (Q2) on the 95PC board is shifted potentially toward "turn off".

3.3 DETAILED CIRCUIT DESCRIPTION OF THE 95PC: Refer to Figure 3-2 and 5-1 for SCR triggering.

The discussion that follows occurs for the period during one cycle (0° to 360°) of the power line frequency. During this period various transistor operating points are changing. The entire operation is synchronous with power line frequency.

This is a very important factor to remember in troubleshooting since a departure from this condition is usually a positive indication of malfunction.

For reasons of convenience, only (A2A1) trigger amplifier of the three phase units will be discussed. The other amplifier action is identical except that the synchronous action is displaced by 120° leading or lagging.

- 3.3.1 Auxiliary DC Supply: The power transformer (T1) or separate transformer (s) provides an auxiliary source of power for operating the various transistors and control elements. The stepped down AC voltage is applied to the full wave rectifiers (CR1) and CR2) and a pulsating DC source is produced across the load resistor (R1) and smoothed DC across the capacitor (C2) which has the pulsating component of the DC source decoupled by diode (CR3).

3.3.2 Switching Transistor: The pulsating DC developed across the input load resistor (R1) of the switching transistor (Q1) will provide the periodic turn on and turn off of the charging voltage for the capacitor (C1) and is shown as waveform (B) on Figure 3-2. The charging period is synchronous with the line frequency. The operating level of the transistor base (Q1) is shown in Figure 3-2 as (C).

3.3.3 Time Base: The time base capacitor (C1) has the transistor (Q2) element in the discharge path and this transistor can be considered as a variable resistor element under the control of the 96PC error amplifier transistors (Q3 and Q6). The overall charging and discharging waveform is shown as (D) on Figure 3-2.

The condition of transistors (Q2) as determined by the error, will in turn set the discharging rate of capacitor (C1). When the supply needs more power, the slope of the discharging rate will move in the direction of Slope #1. of Figure 3-3 and when less power is required the rate will move toward Slope #2.

The "turn on" instant of transistor (Q4) as expressed in terms of degree will vary as seen in Figure 3-3 illustration marked as level (E).

The base of the trigger transistor (Q4) is tied to charging capacitor (C1) and when the discharge (as measured from reference) on this capacitor reaches level (E) of Figure 3-2 or 3-3, the transistor (Q4) is turned on. A pulse is derived on the collector of transistor (Q4) and is coupled to the gate of the SCR, the base of transistor (Q2) and the base of transistor (Q3) simultaneously. The pulse to the bases of the two transistors causes a regenerative effect on the pulse by shifting the operating points of the bases toward the "turn on" direction. This combination has the effect of "speeding up" the trigger pulse.

Resistors (R7) and (R8) aid in balancing the load distribution between the two gates and insuring the proper firing of both controlled rectifiers.

A complementary transistor (Q3) is placed in emitter load of transistor (Q4) for general stabilization purpose. The capacitor (C3) overrides this feature momentarily during the triggering period by shifting the operating point of the base of transistor (Q3) as described above.

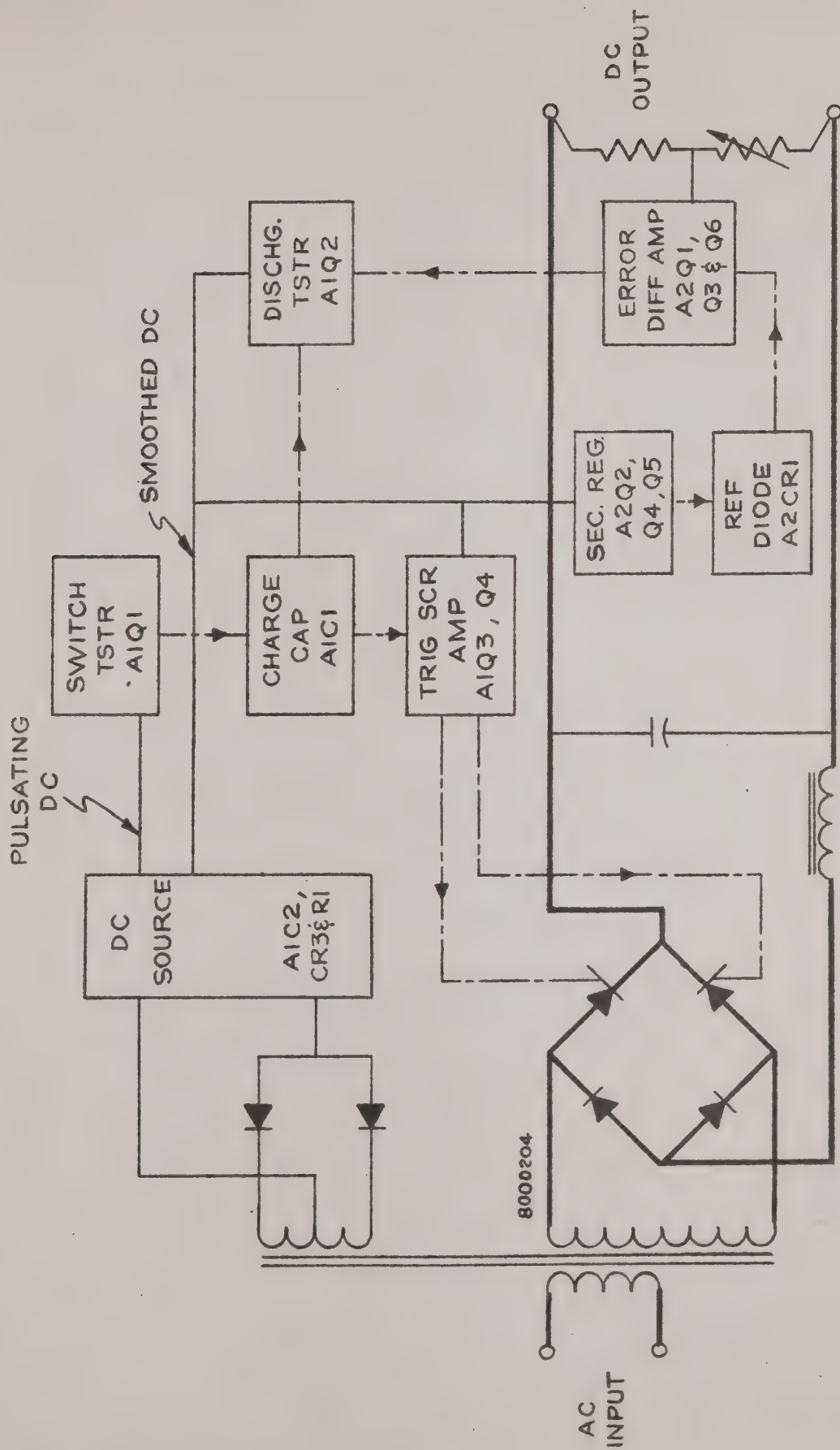


FIG. 3-1A
FUNCTIONAL BLOCK DIAGRAM
SINGLE PHASE MODELS

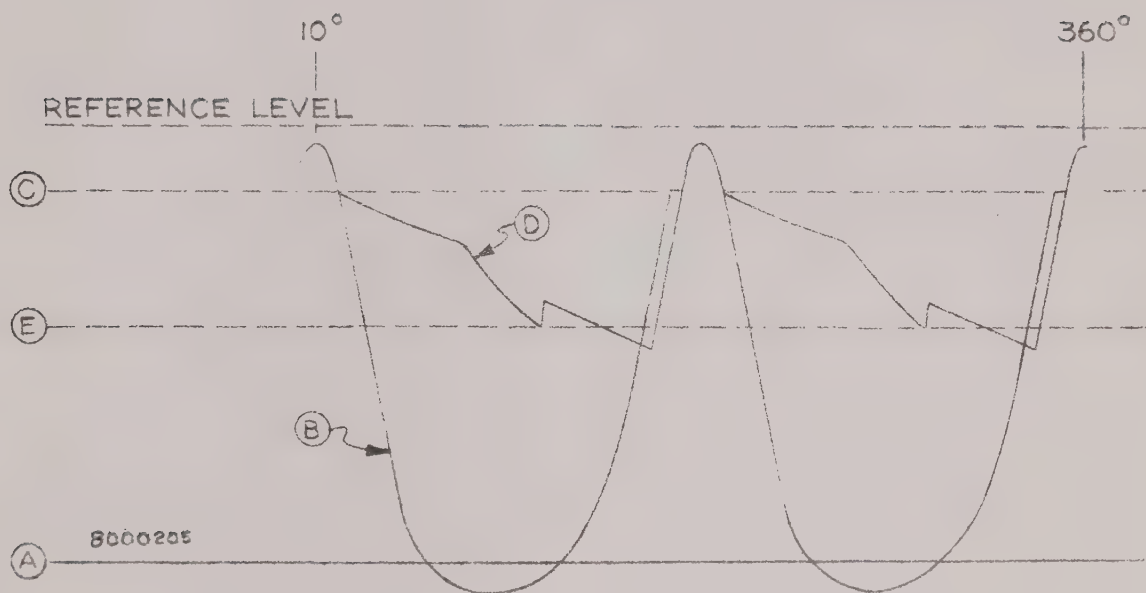


FIG. 3-2

WAVEFORMS CROSS-REFERENCED WITH THE
TRANSISTOR OPERATING LEVEL

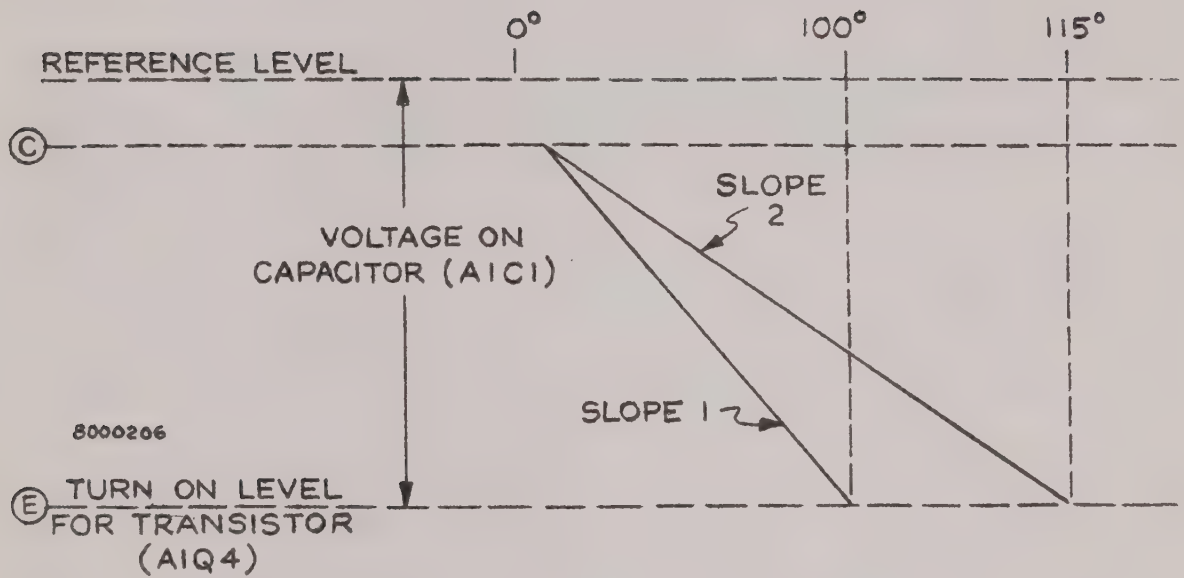


FIG. 3-3

DISCHARGING SLOPE OF TIME BASE CAPACITOR

SECTION IV

MAINTENANCE

4.1. GENERAL: Reference drawings for this power supply are provided in Section V. The exact Schematic Drawing is shown in Figure 5-1. Physical location of components is indicated in the Parts Placement Drawing in Figure 5-2.

This supply is designed for stable operation over long periods of time. However, if trouble develops, standard test equipment normally found in the Electronics Laboratory would be required. If the customer decides to do complete servicing on his premises, one or more of the following pieces of test instruments are required.

Instrument	Range	Remarks
DC Differential Voltmeter	0-500V	Precise regulation check
Oscilloscope	General Purpose	General troubleshooting
Vacuum Tube Voltmeter	General Purpose	Ripple measurements
Multimeter (Ohmmeter)		General troubleshooting
AC Voltmeter (Precision)	0-150V	Precise regulation check
Variable Autotransformer	0-140 V AC 8A	General troubleshooting
Dummy Load	Range depends on supply rating	

WARNING !!

THE POWER SUPPLY SHALL
BE DE-ENERGIZED WHENEVER
ANY COMPONENTS ARE REPLACED.

4.2.1 PREVENTATIVE MAINTENANCE: The principal item that will require attention is the cooling arrangement. The power supply generally requires some amount of convection air currents for cooling purposes. Some high power units have forced air cooling. If the air currents are dust laden, a problem will arise that can lead to premature component deterioration.

This condition reduces the cooling efficiency of the supply. We therefore recommend a periodic cleaning if dusty climate prevails.

CAUTION.!!

VACUUM CLEANER MAY LOOSEN THE SMALL PLUG-IN TRANSISTORS.

4.2.2 Procedure for Oiling the Rotron Muffin fan: The fan (if provided) may require oil if operated under extreme environmental conditions. The fan incorporates the latest electrical and mechanical advances in the motor design and offers reliable performance for 2 to 5 years under favorable conditions of temperature and vibration without the necessity of oiling. Its life is in inverse proportion to these factors. For example, at 110°F the fan may be expected to give reliable performance in excess of three years and at 40°F reliable performance is extended beyond five years.

If the power supply (equipped with fans) should be installed in areas of greater heat, or severe vibration, the life of the fan may be extended by periodic oiling (a small amount once per year) which is absorbed by the bearing. For this oiling procedure, an OIL INJECTOR NJE Part No. 021988 is required and may be ordered from NJE Corporation. This OIL INJECTOR will service from 15 to 20 FANS. For refills order Fan Lubricant NJE Part No. 020923 in 4 oz. can.

Procedure:

- Step 1: Remove cap from end of OIL INJECTOR
- Step 2: Place needle at the center of circle marked on the Gold Label.
- Step 3: Position the needle at an angle of approximately 45° to the surface of the label and tangent to the perimeter of the circle.
- Step 4: Pierce the label and the concealed self-sealing rubber cap located under the label.
- Step 5: Insert the needle approximately 1/4".
- Step 6: Depress the plunger of the OIL INJECTOR slowly to the next calibration mark which will allow 1/16" of oil to escape.

NOTE: it is better to give a little more oil than not enough. However, do not overflow the well. If the ambient temperatures are extremely hot, it may be advisable to oil more frequently to insure the optimum performance characteristics of the fan.

4.3 MEASUREMENTS AND TESTS

4.3.1 Sensing Connection: Sensing lead connections are of utmost importance in making proper regulation measurements. It is recommended that the sensing connections be made directly at the output terminal points rather than at a remote load point. Although the regulation measurement should check correctly at a remote point as well as at the supply terminals, it is well to ascertain that the power supply itself is operating properly without introducing the possibility of extraneous external wiring problems. Thus, all measurements should be made with "local" sensing connections, i. e., with the Sensing terminals jumpered directly to the corresponding Output terminals. One other point of caution in proper measurement technique is the following:

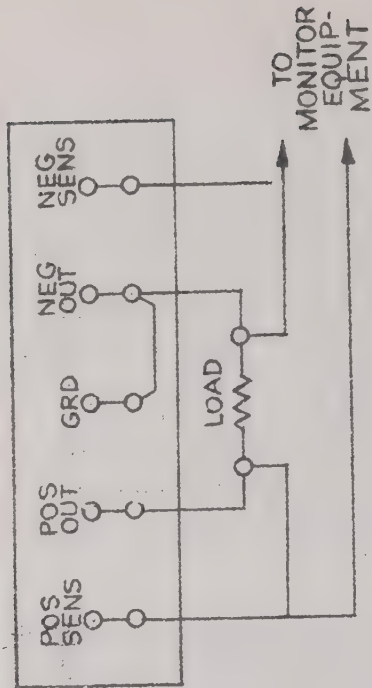
It is absolutely essential that the measuring equipment connections be made directly to the sensing terminals, whereas the load lead connections must be made directly to the Output terminals. Figure 4-1 shows proper and improper connections for measurements taken with "local" and "remote sensing" connections.

Various measurements can be made using essentially the same connections, but using different instrumentation. The following paragraphs describe the basic parameters which may be tested.

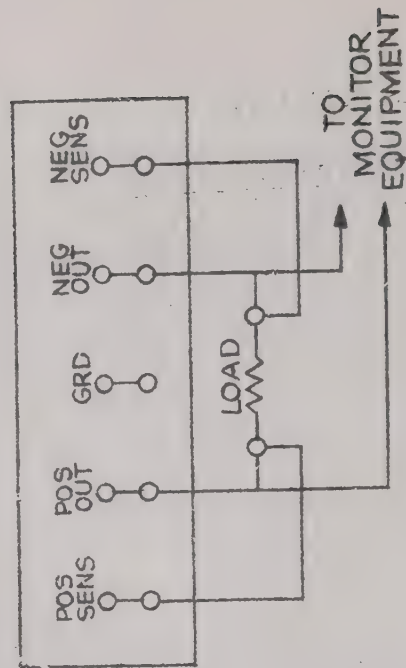
4.3.2 Regulation Checks: Since regulation of modern power supplies can be as low as 0.001%, special measuring techniques must be employed to accurately check the various regulation parameters. It is necessary to use an external source of DC voltage of approximately the same value as the power supply output as a "bucking" source, connected as shown in Figure 4-2. This DC bucking voltage can be either an electronic, null balance differential voltmeter, or a group of batteries connected in series (or another power supply), furnishing a DC potential slightly larger than the output voltage of the power supply under test. When using an differential voltmeter, the voltmeter is built right into the test equipment. When a "bucking" battery is used the voltmeter should have a full-scale range low enough to detect the magnitude of regulation expected.

A multi-tester used on the 1 volt range will usually be adequate, since approximately 10 millivolts can be observed reasonably well. The point to note here is that the voltmeter is used to measure only the difference between two almost equal voltages. The balance adjustment (either in the electronic unit, or the test set-up of the diagram) is used to bring the meter needle to approximately midscale before testing, so that the deviation above or below the normal output of the supply under test can be observed.

CORRECT

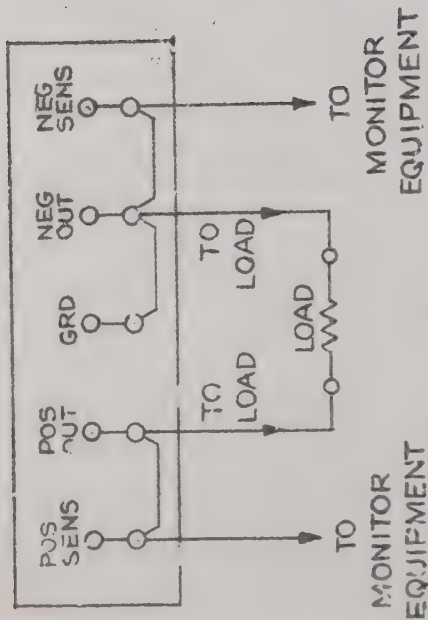


INCORRECT

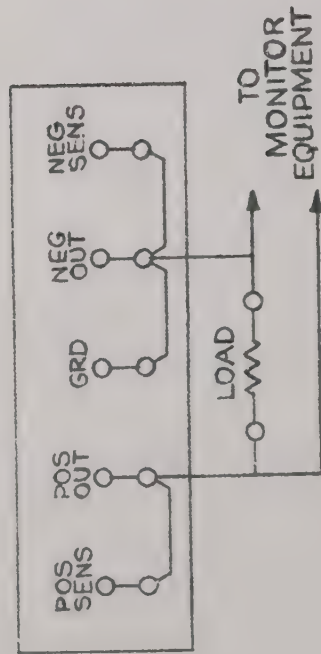


REMOTE SENSING

CORRECT



INCORRECT



LOCAL SENSING

MEASUREMENT CONNECTIONS WITH LOCAL SENSING AND REMOTE SENSING

FIG. 4-1

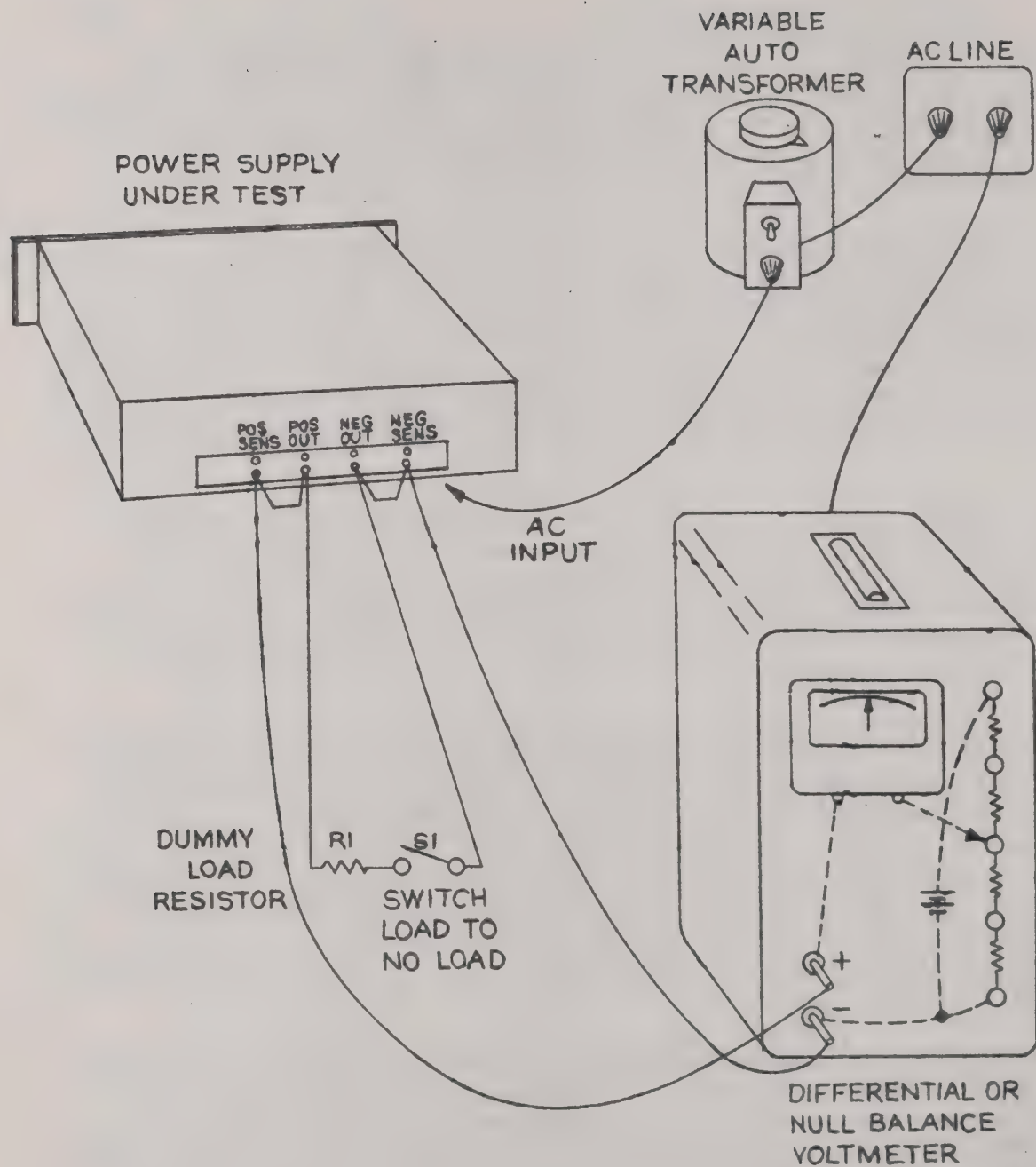
4.3.3 Static Load Regulation: The dummy load (R1) of Figure 4-2 is selected to draw full load current at the nominal output voltage of the supply. The difference between the differential voltmeter readings with the switch open and closed (allowing the needle to come to rest before reading), gives the static load regulation in volts. When load changes are made, it may be necessary to readjust the line voltage to its nominal value.

4.3.4 Static Line Regulation: With the load set at some fixed value, either no load, full load, or some in-between point, the input line is varied by means of the variable auto-transformer shown in Figure 4-2. Note that if this measurement is made under a heavy load condition, the auto-transformer must be selected to supply the necessary input volt-amperes. The difference between the differential voltmeter reading for different line voltage conditions (allowing the needle to come to rest before reading), gives the static line regulation in volts.

4.3.5 Ripple: Either a sensitive VTVM or oscilloscope may be connected directly across the power supply sensing terminals for this measurement. The same set-up as used for the regulation checks may be used if it is desired to observe the ripple under different conditions of the voltage and load current. Be sure to make the measurement connections at the sensing terminals rather than at the load terminals.

4.3.6 Dynamic Regulation and Recovery Time: In the test-set-up described above for Static Load or Line Regulation, a calibrated oscilloscope should be substituted for the differential voltmeter. Maximum deflection and recovery time are measured directly as a dummy load of appropriate value is switched in and out of the circuit. A mercury switch is recommended to minimize arcing, or else an electronic switch should be used. If available, the latter is highly desirable, since the response is readily displayed on the oscilloscope. If recovery time is the parameter under investigation, the switch must be such that the rise and fall time of the current step be at least five times faster than the anticipated recovery time.

4.3.7 Stability: A detailed check for improper drift and intermittent failure can be made by utilizing the same test arrangement as for static regulation measurements. The only requirement is that the differential voltmeter used must have stability of an order of magnitude better than that of the power supply. If available, a stable recorder may be substituted for the differential voltmeter in the drawing, thereby procuring a continuous tracing of the power supply stability.



REGULATION CHECK
TYPICAL LAYOUT

FIG. 4-2

4.4 TROUBLESHOOTING:

4.4.1 SINGLE PHASE UNITS: There are various types of troubles possible with this supply. The following procedure diagnoses the most likely type of trouble. Physical location of components is indicated in the Parts Placement Drawings of Figure 5-2.

NO OUTPUT

SYMPTOM	POSSIBLE CAUSE	REMARKS
Fuse blown	C1 shorted CR1 to CR4 defective	
Fuse not blown	CR5 defective, 95PC or 96PC subassembly faulty or an open circuit.	Check if SCR has been "turned off" by printed circuit board.

LOW VOLTAGE OUT

SYMPTOM	POSSIBLE CAUSE	REMARKS
Voltage movable	Defective reference diode A2 CR1 Defective R2 or A2 R19	
Voltage stability low	95PC or 96PC sub-assembly defective Defective A2 C6	Check if SCR has been partially "turned on".

HIGH VOLTAGE OUT

SYMPTOM	POSSIBLE CAUSE	REMARKS
Constantly high voltage	95PC or 96PC	Check if SCR has been permanently "turned on".

TROUBLESHOOTING (con't)

NO REGULATION

SYMPTOM	POSSIBLE CAUSE	REMARKS
Do not operate unit until the sensing terminals are checked for proper connections.		

POOR REGULATION

SYMPTOM	POSSIBLE CAUSE	REMARKS
Regulation poor under load or line changes	Defective CR1 to CR4	
	Defective transistor on 95 PC or 96PC subassembly	

4.4.2 THREE PHASE UNITS:

NO OUTPUT

SYMPTOM	POSSIBLE CAUSE	REMARKS
Fuse blown	A2 C1 shorted A2 CR1 to CR6 defective	
Fuse not blown	CR 5 defective or 95 PC or 96 PC	Check if SCR has been "turned off" by either printed circuit board.

LOW VOLTAGE OUT

SYMPTOM	POSSIBLE CAUSE	REMARKS
Voltage movable	Defective reference diode A2A4 CR1. Defective A1 R1 or (A2A4 R19)	
Voltage stability low	95 PC or 96 PC Defective A2 A4 C3	Check if SCR has been partially "turned off".

HIGH VOLTAGE OUT

SYMPTOM	POSSIBLE CAUSE	REMARKS
Constantly high voltage	95 PC or 96 PC	Check if SCR has been permanently "turned on".

NO REGULATION

SYMPTOM	POSSIBLE CAUSE	REMARKS
Do not operate unit until the sensing terminals are checked for proper connections.		

SYMPTOM	POSSIBLE CAUSE	REMARKS
Regulation poor under load or line changes	Defective A2 CR1 To A2 CR2 Defective transistor on 95 PC or 96 PC.	

4.5 ALIGNMENT AND ADJUSTMENT: The power supply has the following controls that are factory adjusted and normally do not require attention in the field. If any of the components in the error-difference amplifier are replaced, the following readjustment procedure may be necessary.

4.5.1 OUTPUT ADJUST Calibration:

Step 1: Set OUTPUT ADJUST variable resistor (R2) (or R1 on three-phase models) completely clockwise. The unit may be operated at nominal line and at no load.

Step 2: Place calibrated voltmeter across output.

Step 3: Adjust variable resistor (R10) of the 96 PC error amplifier board until full rated output voltage is reached.

4.5.2 STABILITY CONTROL: (R17) of the 96 PC error amplifier board is used as a stabilization control and may require readjustment in the event that any component is changed. The power supply should be checked at various points within its voltage and current operating range to ascertain that it is stable at all conditions.

4.5.3 TRIG AMPLITUDE ADJUST: On three phase units. (A2R1, A2R2, A2R3) are used to balance the output waveshape under full load conditions. Starting with the three controls shorted out, and observing the ripple waveshape of the output on an oscilloscope, bring each control up as little as possible to obtain a smooth 360 cps ripple waveshape.

4.6. ERROR-DIFFERENTIAL AND SECONDARY REGULATION AMPLIFIER CHECK: There are several methods which can be used in checking the performance and condition of these amplifiers.

Except for individually removing the transistors for a check by means of a transistor test set, and making continuity and resistance tests on the circuit and components, all methods require the amplifier to be energized with the proper potentials under the conditions found in the power supply for normal operation. For this reason, it is simplest to test the amplifier in position in the supply, first making certain that its DC power supply transformer (T1), or separate transformer semiconductor devices, (CR1 to CR4), diodes (CR6 and CR7) and resistor (R1) are functioning properly. This can be quickly ascertained by checking the circuit voltages on the schematic diagram. Once this is done, the procedure given below can be used to check out the amplifier itself.

4.7. SIGNAL TRACING CHECK: Since there is an inherent amount of ripple at the input of the amplifiers, this ripple signal can be used as a test signal for observing the amplifier performance with the aid of a test oscilloscope. (Ignore any spikes in the waveform). Use only the basic ripple signal when making amplitude calculations. In the event that the ripple is too small for practical use, a small 60-cycle sine wave voltage of convenient amplitude (less than 0.25 volt) can be injected into the secondary regulator amplifier by applying it to the base of transistor (A2Q4) on printed circuit board, located on the 96PC. Measurement of the ripple at the input to the amplifier, and at the output of each successive amplifier stage will provide an effective check of amplifier performance. The ripple amplitude measured at the base (or input) of the second stage transistors (A2Q5) should be 20 to 40 times the amplitude at the input to the first stage. Radical departure from this set of conditions will point up a defective component or connection, which can then be isolated by inspection and individual test. Be sure not to overdrive the amplifier stages as it will cause misleading results.

In a manner similar to above, apply a small 60-cycle sine wave voltage of convenient amplitude (less than 0.25 volt) to the base of transistor (A2Q6). The ripple amplitude measured at the base of transistor (A2Q3) should be 20 to 40 times the amplitude at the base of the first stage transistor (A2Q3). The ripple at the emitter of the transistor (A2Q3) will be almost identical to the base ripple. This is an emitter-follower stage.

As above, any radical departure from this set of conditions will point up a defective component or connection, which can then be isolated by inspection and individual tests. Be sure not to overdrive the amplifier stages as this will cause misleading results.

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4.8. STABILITY CHECK: A detailed check for improper drift and intermittent failure can be made by utilizing a test arrangement similar to that shown for regulation check in Figure 4-2. The voltage across the breakdown diode reference source (A2CR1) is "bucked out", and monitored by a 0 to 1-volt (or smaller scale, if available) high impedance DC voltmeter (null balance voltmeter). Drift or random instability will be readily visible in this test. Output voltages of the successive amplifier stages can then be monitored in the same manner. When checking a given amplifier stage by this method, the output of the previous stage should be shorted, to prevent external voltage variations from reaching the stage under test. This does not include shorting the output terminals of the power supply. Care must be exercised to guard the load circuit from extraneous fields. When installing a new transistor in place of one shown to be defective, the stability check should be repeated to make certain that the trouble has been eliminated.

OVERVOLTAGE CIRCUIT CALIBRATION PROCEDURE:

(For Units Equipped With (OV Option Only).

- Step 1: Refer to the schematic diagram for the over-voltage circuit. Remove (Q1) Item (C), from its socket.
- Step 2: Set R14, Item (D) to approximately its middle position.
- Step 3: Energize the power supply and set the OUTPUT ADJUST potentiometer for rated maximum output voltage.
- Step 4: Adjust (R12), Item (E), to its most counter-clockwise position.
- Step 5: Place a voltmeter across (R5), points (A), and adjust (R12), Item (E) just to the point where the voltage jumps to a value above 6 or 7 volts.
- Step 6: Check the voltage across points (B). This should read between 9 and 11 volts.
- Step 7: Turn (R14), Item (D), to its most counter-clockwise position.
- Step 8: Set the OUTPUT ADJUST for the desired over-voltage trip point, using the front panel voltmeter when so equipped, or an external monitor.
- Step 9: Replace transistor (Q1).
- Step 10: Slowly rotate (R14) clockwise until the over-voltage circuit operates. This is evidenced by the output voltage suddenly falling to a low value.
- Step 11: Lower the OUTPUT ADJUST level slightly.
- Step 12: Replace the primary fuse which will have been blown in Step 10 above.

VOLTAGE (D. C. VOLTS FOLLOWS UNLESS OTHERWISE SPECIFIED)

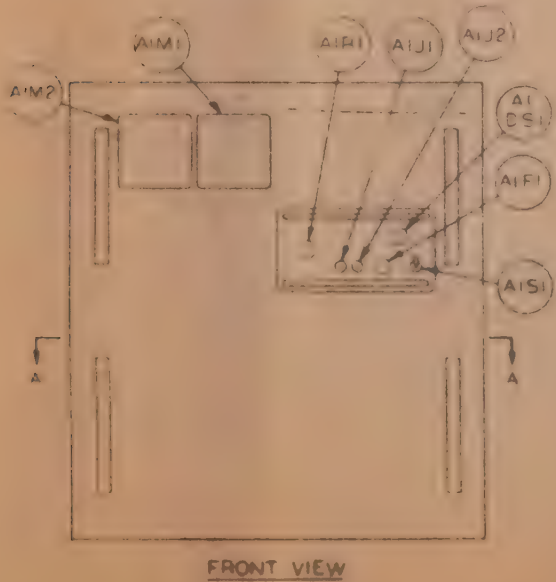
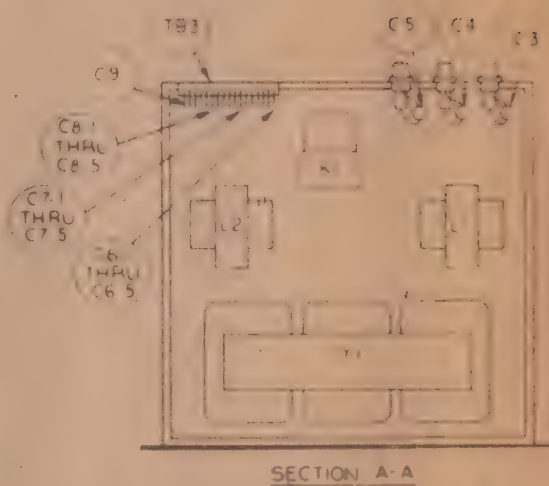
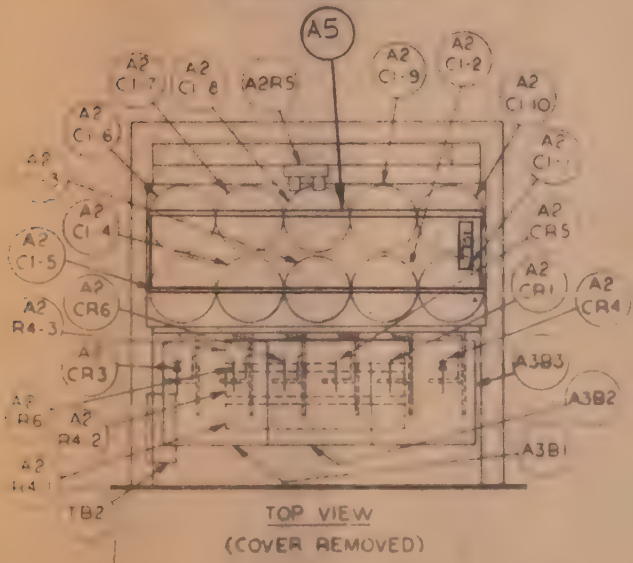
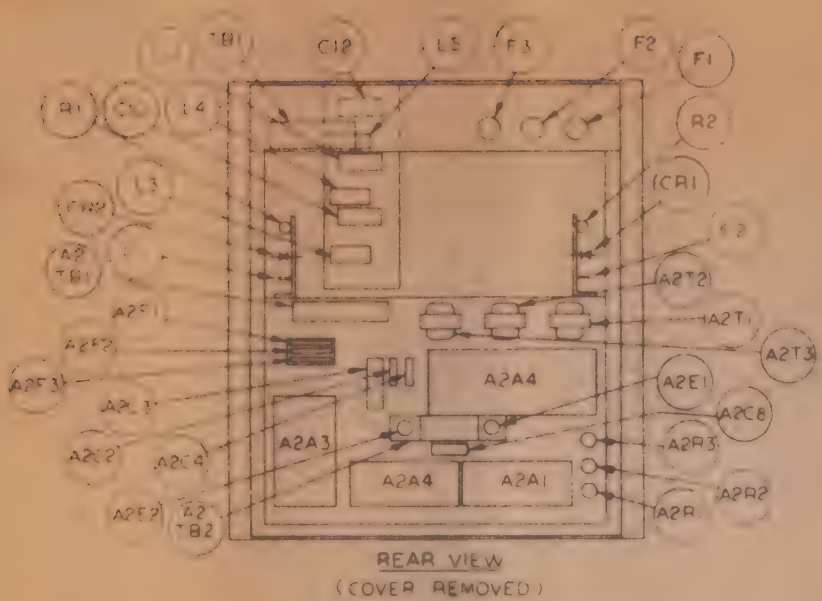
TEST POINT	TC14-15	TC32-10	TC52-6	TC80-4	TC14-30	TC32-20	TC52-12	TC80-8	TC100-6	TC32-30	TC32-50	TC52-30	TC80-8
A2-TERM. #5	5.6± 5%												5.6± 5%
A2-TERM. #8	8-9												8-9
BASE-A2 Q4	4.9-6												4.9-6
COL. -A2 Q4	0.15-0.2												0.15-0.2
A2 - TERM. #1	9-12												9-12
BASE - A2 Q3	0.6-2												0.6-2
BASE-A2 Q7	8.2-9.0												8.2-9.0
A2 - TERM. #7	2.5-3.2												2.5-3.2
A1 - TERM. #7	0.15-0.8												0.15-0.8
BASE - A1 Q1	7-9												7-9
A1 - TERM. #10	4-5.5												4-5.5
COL. - A1 Q3	9-12												9-12
COL. - A1 Q4	0.2-1.0												0.2-1.0
A2 - TERM. #11	0.19-0.22												0.19-0.22
A2 - TERM. #2	(-) 14	(-) 32	(-) 52	(-) 80	(-) 14	(-) 32	(-) 52	(-) 80	(-) 100	(-) 32	(-) 32	(-) 52	(-) 80
A2 - TERM. #6	(-) 4.36	(-) 6.4	(-) 15.9	(-) 17	(-) 4.36	(-) 6.4	(-) 15.9	(-) 17	(-) 32	(-) 6.4	(-) 6.4	(-) 15.9	(-) 17
CATH. OF CR 6	(-) 15.7	(-) 34.1	(-) 54.2	(-) 84.1	(-) 15.8	(-) 34	(-) 54.6	(-) 84	(-) 103.2	(-) 34	(-) 34	(-) 54.3	(-) 83
A1 - TERM. #6	0.15-0.8												0.15-0.8
L. - A1 Q2	5.2-6.2												5.2-6.2
A1 - TERM. #14	0.15-0.35												0.15-0.35
A1 - TERM. #11	0.15-0.35												0.15-0.35
EMIT. - A1 Q1	2-4												2-4
A1 - TERM. #4	1.8-2.5												1.8-2.5
A1 - TERM. #1-#2	9.95VAC												9.95VAC
A1 - TERM. #1-#3	9.95VAC												9.95VAC
I - TERM. #12-#13	28VAC	48VAC	77VAC	116VAC	29VAC	51VAC	81.5VAC	123VAC	150VAC	52VAC	55.5VAC	83VAC	121VAC

NOTE: ALL VOLTAGES ARE MEASURED WITH RESPECT TO THE GND TERMINAL WITH UNIT OPERATING AT 100% OUTPUT VOLTAGE & MAY LOAD CURRENT LIMIT 100%

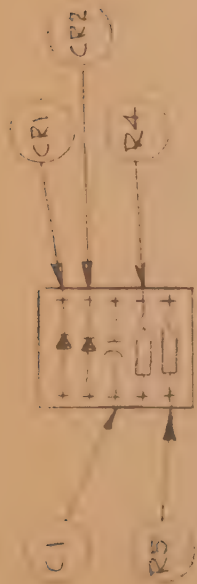
VOLTAGE MEASUREMENTS

TABLE 5-2

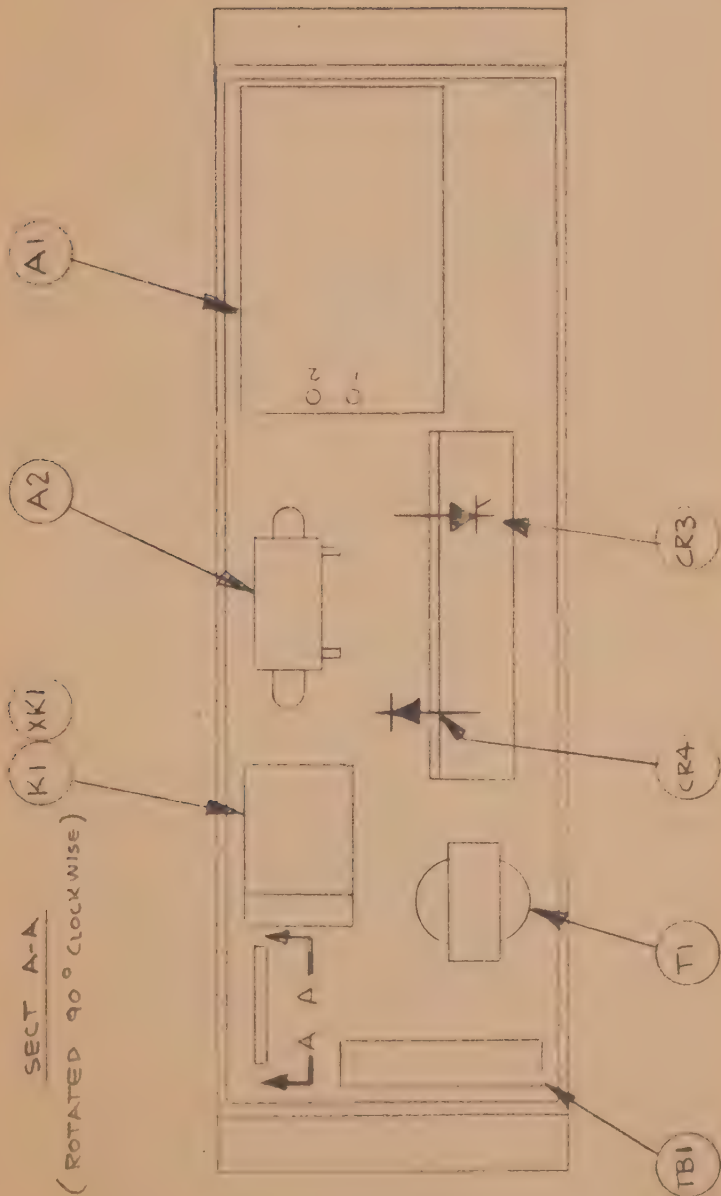
501000



PARTS PLACEMENT-MAJOR COMPONENTS
FIG. 5-2A

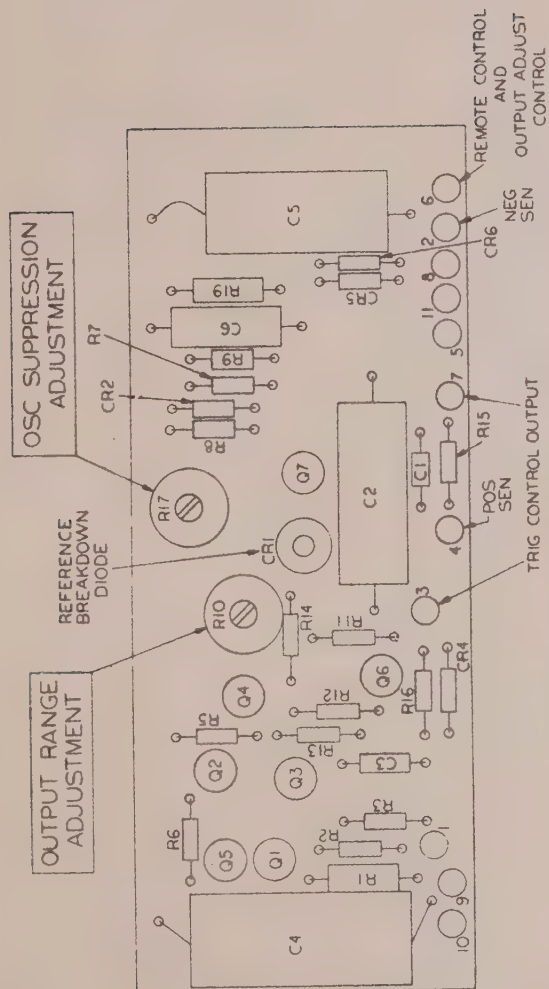


SECT A-A
(ROTATED 90° CLOCKWISE)

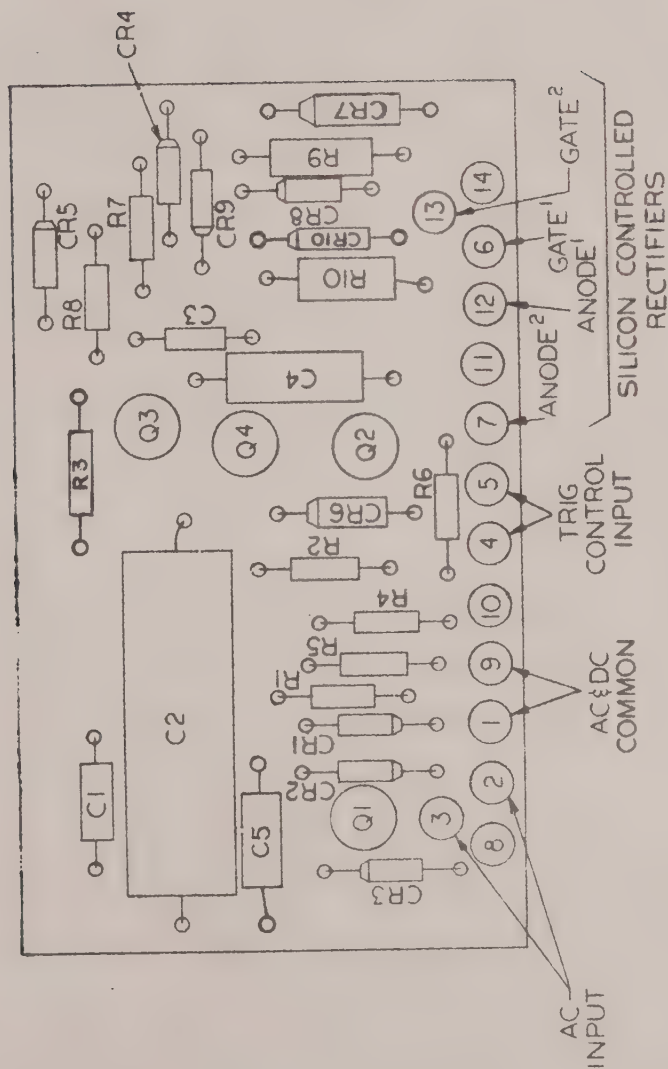


TOP VIEW

PARTS PLACEMENT 1-OV-1



PARTS PLACEMENT
ERROR AMP SUBASSEMBLY (96 PC)
FIG. 5-28



PARTS PLACEMENT
SCR TRIGGER AMP SUBASSEMBLY (95 PC)
FIG. 5-2C

ABBREVIATIONS USED IN SPARE PARTS LIST

In Description Column: "SA" is used to mean "Same As" and "PO" is used to mean "Part Of". Where these symbols are used, the UNIT QTY, SPARE QTY, UNIT PRICE and NJE PART NO. columns are all blank.

In Value Column: The use of the letter R to indicate a decimal point is illustrated by the following examples: 5.6K Ω is written as 5R60K. 1/2 Watts is written as R500 W. The use of zeroes does not imply a precision to the indicated number of decimal places but is a requirement of the proper handling of the Data Processing Cards from which these spare parts lists are written.

The standard symbols for electrical units are used and usually appear in the columns immediately to the left of the dashed and solid lines in the Value field. In all cases, the symbol Ω is not printed for resistors and is understood. For example: 200 Ω is written 200 and 2.7M Ω is written 2R70 M.

In Reference Designation Column: The reference designations are those which inter-relate the Spare Parts List, the Schematic Diagrams and the Parts Placement drawings. The symbols are those of MIL - STD 16. Where the reference designation is an "A" (meaning a subassembly) a Spare Parts List bearing the NJE Part Number of that assembly is included in the Spare Parts List section.

Deviations: Where minor deviations are accomplished by modifying a standard unit, a Spare Parts List which only shows the deletions and additions from the enclosed standard Spare Parts List is used.

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REFERENCE DESIGNATION	DESCRIPTION VENDOR NAME*	RATINGS VENDOR PART NO.*	NJE PART NO.	QTY. USED	SPARE QTY.	UNIT PRICE
	FOLLOWING SPARE PARTS LIST IS MODIFIED AS INDICATED BELOW					
	CHASSIS 01366					
	AMP					
40	AMPLIFIER	AMPLIFIER ASSY	82602	01	01	
	1 CV 1		82603			
41	CKT CARD ASSY	CKT CARD ASSY	82603	01	01	
42	DES SUBASSY	DES SUBASSY	82604	01	01	
51	CAP FWD FLCT	100UF 150 V	877	01	01	1.00
501	DIODE RECTIFIED 5	750MA 300 V	137	05	01	1.00
502	SA CR1			01		
503	RECTIFIED CONTROL	25 A 100 V	140	01	01	17.00
504	DIODE	100 A 200 V	487	01	01	17.00
51	RELAY		3438	01	01	10.00
51	NOT USED					
52	NOT USED					
53	NOT USED					
54	DES FWD COMP SPCT	2.70 W 2 W	100	01	01	.36
55	DES FWD WY	100.00 10 W	249	01	01	1.00
51	TRANSFORMER	55V .4A	20013	01	01	20.00
501	TERMINAL BOARD	5 TERM 15 A	486	01	01	.90
501	LOCKET TUNE	SPIN CATAL	240	01	01	.30
	11200 7		82605			
52	CAP FWD CYCLIC	8000UF 25 V	5222	01	01	6.00
51	CAP FWD CYCLIC	847UF 50 V	20861	01	01	6.00
501	NOT USED					
502	RECTIFIED CONTROL	25 A 100 V	100	01	01	17.00
503	DIODE RECTIFIED 100V	1500MA 5.5 V	125	01	01	5.00
51	TRANSISTOR NPN 51	1 W 45 V	2080	02	01	4.00
52	SA 01					
53	TRANSISTOR NPN 51	200MA 50 V	8298	01	01	2.00
54	TRANSISTOR NPN 51	200MA 15 V	21711	05	01	7.00
55	SA 02					
51	DES FWD WY	150000 5 W	1593	01	01	1.00
52	NOT USED					
53	DES FWD COMP	270.00 .500 W	81	01	01	.10
54	DES FWD COMP SPCT	1.00W .500 W	481	01	01	.70
55	DES FWD COMP SPCT	2.70W .500 W	100	01	01	.20
56	DES FWD WY	220.00 1 W	60	01	01	.20

*SPARE PARTS LIST SPECIFYING TYPICAL VENDOR'S NAME AND PART NUMBER IS AVAILABLE ON SPECIAL ORDER ONLY.

- 1 - When ordering spare parts it is necessary to specify the serial number and model number (available on the warranty label on the rear of the unit) and the NJE Part No. from this spare parts list.
- 2 - Unit Price shown above is subject to change without prior notice.
- 3 - NJE Corp. reserves the right to make design improvements on this unit without prior notice.
- 4 - Spare Quantity shown above is recommended quantity for one year isolated service.

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REFERENCE DESIGNATION	DESCRIPTION VENDOR NAME*	RATINGS VENDOR PART NO.*	NJE PART NO.	QTY. USED	SPARE QTY.	UNIT PRICE
P7	OFF FWD W/	1000 W 3 W	1597	02	01	1.00
P8	SA P7					
P9	OFF FWD W/	2.75 W 3 W	1598	01	01	.50
P10	OFF FWD W/	1.50 W 2 W	1599	01	01	.50
P11	OFF FWD W/	470.00 7 W	1676	01	01	.50
P12	OFF VAD W/	700.00 2 W	20017	01	01	1.75
P13	OFF FWD W/	750.00 3 W	1244	01	01	.50
P14	OFF VAD W/	1.00 W 2 W	20041	01	01	1.75
X01	POWER TRANSISTOR	4014	122	02	01	.70
X02	SA X01					
X03	SA X01					
X04	SA X01					
X05	SA X01					
	RES GUMBERY		20508			
P1	RES FWD W/	.25 40 W	10537	02	01	1.00
P2	SA P1					
P3	SA P1					
	TC32 120		81360			
P1	FRONT PANEL ASSY		81367	01	01	
P2	CHASSIS ASSY		81366	01	01	
P3	GLOSTER ASSY		81367	01	01	
C1	CAP FWD CERAMIC	5100 500 V	157	21	02	1.00
C2	SA C1					
C3	SA C1					
C4	SA C1					
C5	SA C1					
C6 1	SA C1					
C6 2	SA C1					
C6 3	SA C1					
C6 4	SA C1					
C6 5	SA C1					
C7 1	SA C1					
C7 2	SA C1					
C7 3	SA C1					
C7 4	SA C1					
C7 5	SA C1					
C8 1	SA C1					
C8 2	SA C1					
C8 3	SA C1					
C8 4	SA C1					
C8 5	SA C1					
C9	SA C1					

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REFERENCE DESIGNATION	DESCRIPTION VENDOR NAME*	RATINGS VENDOR PART NO.*	NJE PART NO.	QTY. USED	SPARE QTY.	UNIT PRICE
C10	CAP 500 PAPER	100UF 600 V	452	03	01	.70
C11	CA C10					
C12	CA C10					
CR 1	DIODE RECTIFIED 2	35 A 200 V	107199	03	01	6.00
CR 2	CA CR1					
F1	FUSE CARTRIDGE	20000 A 100 V	526	03	01	1.70
F2	SA F1					
F3	SA F1					
K1	DELAY	10ST 20A 115 V	517	01	01	25.00
L1	REACTOR		109700	01	01	42.50
L2	REACTOR		109701	01	01	42.50
L3	REACTOR		521	03	01	8.00
L4	SA L3					
L5	SA L3					
R1	RES 500 W	100000 25 W	80	02	01	1.40
R2	SA R1					
T1	TRANSFORMER		204804	01	01	295.00
TR1	TERMINAL BOARD	5 TERM 20 A	508	01	01	1.00
TR2	CONNECTOR 24IN	10 PIN 15 A	107000	01	01	1.00
TR3	TERMINAL BOARD	10 TERM 5 A	204	01	01	1.00
XF1	FUSE HOLDER	30 A 250 V	212	03	01	1.00
XF2	SA XF1					
XF3	SA XF1					
	FRONT PANEL ASSY		01363			
DL1	PILOT LAMP	T3 0 2500 W	24	01	01	.70
F1	FUSE CARTRIDGE	2000 A 250 V	25	01	01	.70
J1	CONNECTOR RECEPT	1 PIN 30 A	12	01	01	.80
J2	CONNECTOR RECEPT	1 PIN 30 A	12	01	01	.80
M1	AMMETER AC	10000 A 500V	510	01	01	25.00
M2	VOLTMETER AC	4000 V	47	01	01	25.00
R1	RES 500 W	5000 W 2 W	107	01	01	5.00
R2	SWITCH	10ST 15 A	20400	01	01	1.00
XS1	LANDHOLDER	50 CLEAR 125 V	109001	01	01	1.10
XF1	FUSE HOLDER	30 A 250 V	20811	01	01	.70
	CHASSIS ASSY		01360			
A1	GAUGE 2		20179	03	01	
A2	SA A1					
A3	SA A1					
A4	GAUGE 3		20730	01	01	
CL 1	CAP 500 ELECT	10000UF 50 V	7	10	02	27.00
CL 2	SA CL 1					
CL 3	SA CL 1					

*SPARE PARTS LIST SPECIFYING TYPICAL VENDOR'S NAME AND PART NUMBER IS AVAILABLE ON SPECIAL ORDER ONLY.

- 1 - When ordering spare parts it is necessary to specify the serial number and model number (available on the warranty label on the rear of the unit) and the NJE Part No. from this spare parts list.
- 2 - Unit Price shown above is subject to change without prior notice.
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- 4 - Spare Quantity shown above is recommended quantity for one year isolated service.

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REFERENCE DESIGNATION	DESCRIPTION VENDOR NAME*	RATINGS VENDOR PART NO.*		NJE PART NO.	QTY. USED	SPARE QTY.	UNIT PRICE
CI A	SA CI 1						
CI B	SA CI 1						
CI C	SA CI 1						
CI D	SA CI 1						
CI E	SA CI 1						
CI F	SA CI 1						
CI G	SA CI 1						
CI H	SA CI 1						
CI I	SA CI 1						
CI J	SA CI 1						
CI K	CAP FWD ELECT	2000UF	15 V	167	01	01	2.00
CI L	CAP FWD ELECT	2000UF	15 V	161747	01	01	4.00
CI M	CAP FWD ELECT	2000UF	15 V	482	01	01	1.75
CI N	CAP FWD CERAMIC	100UF	500 V	167	01	01	1.25
CI O	RECTIFIED CONTROL	SA A	100 V	367	05	05	47.50
CI P	SA CI						
CI Q	SA CI						
CI R	SA CI						
CI S	SA CI						
CI T	SA CI						
CI U	SA CI						
CI V	SA CI						
CI W	SA CI						
CI X	SA CI						
CI Y	SA CI						
CI Z	SA CI						
CI AA	SA CI						
CI AB	SA CI						
CI AC	SA CI						
CI AD	SA CI						
CI AE	SA CI						
CI AF	SA CI						
CI AG	SA CI						
CI AH	SA CI						
CI AI	SA CI						
CI AJ	SA CI						
CI AK	SA CI						
CI AL	SA CI						
CI AM	SA CI						
CI AN	SA CI						
CI AO	SA CI						
CI AP	SA CI						
CI AQ	SA CI						
CI AR	SA CI						
CI AS	SA CI						
CI AT	SA CI						
CI AU	SA CI						
CI AV	SA CI						
CI AW	SA CI						
CI AX	SA CI						
CI AY	SA CI						
CI AZ	SA CI						
CI BA	SA CI						
CI BB	SA CI						
CI BC	SA CI						
CI BD	SA CI						
CI BE	SA CI						
CI BF	SA CI						
CI BG	SA CI						
CI BH	SA CI						
CI BI	SA CI						
CI BJ	SA CI						
CI BK	SA CI						
CI BL	SA CI						
CI BM	SA CI						
CI BN	SA CI						
CI BO	SA CI						
CI BP	SA CI						
CI BQ	SA CI						
CI BR	SA CI						
CI BS	SA CI						
CI BT	SA CI						
CI BU	SA CI						
CI BV	SA CI						
CI BW	SA CI						
CI BX	SA CI						
CI BY	SA CI						
CI BZ	SA CI						
CI CA	SA CI						
CI CB	SA CI						
CI CC	SA CI						
CI CD	SA CI						
CI CE	SA CI						
CI CF	SA CI						
CI CG	SA CI						
CI CH	SA CI						
CI CI	SA CI						
CI CJ	SA CI						
CI CK	SA CI						
CI CL	SA CI						
CI CM	SA CI						
CI CN	SA CI						
CI CO	SA CI						
CI CP	SA CI						
CI CQ	SA CI						
CI CR	SA CI						
CI CS	SA CI						
CI CT	SA CI						
CI CU	SA CI						
CI CV	SA CI						
CI CW	SA CI						
CI CX	SA CI						
CI CY	SA CI						
CI CZ	SA CI						
CI DA	SA CI						
CI DB	SA CI						
CI DC	SA CI						
CI DD	SA CI						
CI DE	SA CI						
CI DF	SA CI						
CI DG	SA CI						
CI DH	SA CI						
CI DI	SA CI						
CI DJ	SA CI						
CI DK	SA CI						
CI DL	SA CI						
CI DM	SA CI						
CI DN	SA CI						
CI DO	SA CI						
CI DP	SA CI						
CI DQ	SA CI						
CI DR	SA CI						
CI DS	SA CI						
CI DT	SA CI						
CI DU	SA CI						
CI DV	SA CI						
CI DW	SA CI						
CI DX	SA CI						
CI DY	SA CI						
CI DZ	SA CI						
CI EA	SA CI						
CI EB	SA CI						
CI EC	SA CI						
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CI FN	SA CI						
CI FO	SA CI						
CI FP	SA CI						
CI FQ	SA CI						
CI FR	SA CI						
CI FS	SA CI						
CI FT	SA CI						
CI FU	SA CI						
CI FV	SA CI						
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CI GH	SA CI						
CI GI	SA CI						
CI GJ	SA CI						
CI GK	SA CI						
CI GL	SA CI						
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CI GN	SA CI						
CI GO	SA CI						
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CI GQ	SA CI						
CI GR	SA CI						
CI GS	SA CI						
CI GT	SA CI						
CI GU	SA CI						
CI GV	SA CI						
CI GW	SA CI						
CI GX	SA CI						
CI GY	SA CI						
CI GZ	SA CI						
CI HA	SA CI						
CI HB	SA CI						
CI HC	SA CI						
CI HD	SA CI						
CI HE	SA CI						
CI HF	SA CI						
CI HG	SA CI						
CI HH	SA CI						
CI HI	SA CI						
CI HJ	SA CI						
CI HK	SA CI						
CI HL	SA CI						
CI HM	SA CI						
CI HN	SA CI						
CI HO	SA CI						
CI HP	SA CI						
CI HQ	SA CI						
CI HR	SA CI						
CI HS	SA CI						
CI HT	SA CI						
CI HU	SA CI						
CI HV	SA CI						
CI HW	SA CI						
CI HX	SA CI						
CI HY	SA CI						
CI HZ	SA CI						
CI IA	SA CI						
CI IB	SA CI						
CI IC	SA CI						
CI ID	SA CI						
CI IE	SA CI						
CI IF	SA CI						
CI IG	SA CI						
CI IH	SA CI						
CI II	SA CI						
CI IJ	SA CI						
CI IK	SA CI						
CI IL	SA CI						
CI IM	SA CI						
CI IN	SA CI						
CI IO	SA CI						
CI IP	SA CI						
CI IQ	SA CI						
CI IR	SA CI						
CI IS	SA CI						
CI IT	SA CI						
CI IU	SA CI						
CI IV	SA CI						
CI IW	SA CI						
CI IX	SA CI						
CI IY	SA CI						
CI IZ	SA CI						
CI JA	SA CI						
CI JB	SA CI						
CI JC	SA CI						
CI JD	SA CI						
CI JE	SA CI						
CI JF	SA CI						
CI JG	SA CI						
CI JH	SA CI						
CI JI	SA CI						
CI JJ	SA CI						
CI JK	SA CI						
CI JL	SA CI						
CI JM	SA CI						
CI JN	SA CI						
CI JO	SA CI						
CI JP	SA CI</						

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REFERENCE DESIGNATION	DESCRIPTION VENDOR NAME*	RATINGS VENDOR PART NO.*	NJE PART NO.	QTY. USED	SPARE QTY.	UNIT PRICE
C01	SA C01					
C02	DIODE RECTIFIED C	150MA 100 V	122	01	01	1.40
C03	SA C01					
C04	SA C01					
Q1	TRANSISTOR PNP GE	200MW 25 V	139	05	01	2.40
Q2	TRANSISTOR NPN GE	150MA 15 V	142	05	01	2.40
Q3	SA Q2					
Q4	SA Q1					
R1	RES FXD 1/2 W	100000 1 W	243	01	01	.30
R2	RES FXD COMP 50CT	270000 2500 W	192	02	01	.20
R3	RES FXD COMP	5000 2500 W	277	01	01	.10
R4	RES FXD COMP 50CT	270000 2500 W	193	01	01	.20
R5	SA R2					
R6	RES FXD COMP 50CT	470000 2500 W	194	01	01	.20
R7	RES FXD COMP	10000 2500 W	177	02	01	.10
R8	SA R7					
R9	RES FXD COMP 50CT	500000 2 W	197	02	01	.30
R10	SA R9					
X01	SOCKET TRANSISTOR	4012	128	04	01	.70
X02	SA X01					
X03	SA X01					
X04	SA X01					
	SA R2		20300			
C1	CAP FXD TANTALUM	1000UF 50 V	213	01	01	1.20
C2	CAP FXD ELECT	2000UF 15 V	145	01	01	2.00
C3	CAP FXD CERAMIC	500000 50 V	212	01	01	1.00
C4	CAP FXD ELECT	2000UF 15 V	146	01	01	2.00
C5	CAP FXD ELECT	500UF 50 V	214	01	01	1.00
C6	CAP FXD ELECT	500UF 50 V	215	01	01	1.00
C01	DIODE RECTIFIED 100C	150MA 100 V	122	01	01	1.40
C02	DIODE RECTIFIED C	700MA 200 V	123	04	01	1.20
C03	SA C02					
C04	SA C02					
C05	SA C02					
Q1	TRANSISTOR PNP GE	200MW 25 V	139	05	02	2.40
Q2	TRANSISTOR NPN GE	150MA 15 V	142	05	01	2.40
Q3	SA Q1					
Q4	SA Q1					
Q5	SA Q1					
Q6	SA Q2					
Q7	SA Q1					
R1	RES FXD COMP	100000 2 W	243	01	01	.30
R2	RES FXD COMP 50CT	470000 2500 W	194	03	01	.20
R3	RES FXD COMP	3000 2500 W	191	01	01	.10

*SPARE PARTS LIST SPECIFYING TYPICAL VENDOR'S NAME AND PART NUMBER IS AVAILABLE ON SPECIAL ORDER ONLY.

- 1 - When ordering spare parts it is necessary to specify the serial number and model number (available on the warranty label on the rear of the unit) and the NJE Part No. from this spare parts list.
- 2 - Unit Price shown above is subject to change without prior notice.
- 3 - NJE Corp. reserves the right to make design improvements on this unit without prior notice.
- 4 - Spare Quantity shown above is recommended quantity for one year isolated service.

PAGE NO.

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MANUFACTURER'S REPRESENTATIVES

*California, Los Angeles

Ault Associates
931 So. Prairie Avenue
Inglewood, California
OR 8-6144

California, San Francisco

Ault Associates
120 Santa Margarita
Menlo Park, California
DA 6-1760

Canada, Montreal

Radionics, Ltd.
8230 Mayrand Street
Montreal, Canada
REgent 9-5517

Canada, Ontario

Radionics, Ltd.
4938 Yonge Street
Willowdale, Ontario
222-3261

Colorado, Denver

Scientific Instrument Company
1435 So. Milwaukee Street
Denver 10, Colorado
AL 5-2777

Florida, Clearwater

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532 South Fort Harrison Ave.
Clearwater, Florida
(813) 446-7072

Florida, Orlando

W. Ben Wimberly Co., Inc.
500 Osceola Street
Orlando, Florida
425-3083

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Chicago 34, Ill.
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Indianapolis 2, Indiana
MElrose 5-2401

Massachusetts, Boston

Burlingame Associates, Ltd.
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Waltham, Mass.
TWinbrook 4-1955

Michigan, Detroit

Ridgway Associates
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Berkley, Michigan
Lincoln 6-3312

Minnesota, Minneapolis

Ridgway Associates
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Minneapolis 23, Minnesota
866-3305

Missouri, Kansas City

Lee Mark Associates
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Shawnee-Mission, Kansas
Niagara 2-3313

Missouri, St. Louis

Lee Mark Associates
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MOunt Vernon 4-7530

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No. Carolina, Burlington

M. J. McDonald Co.
514 Hillcrest Avenue
Burlington, N. Carolina
226-7177

No. Carolina, Winston-Salem

M. J. McDonald Co.
Whippoorwill Drive, Rt. 1
Pilotown, N. C.
WABash 4-2182

Ohio, Dayton

Ridgway Associates
3898 Linden Avenue
Dayton 29, Ohio
CLearwater 2-5604

Ohio, Cleveland

Ridgway Associates
5249 Broadview Road
Cleveland 34, Ohio
(216) 749-6626

Penna., Philadelphia

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Upper Darby, Pa.
JACKson 8-6080

Texas, Dallas

Carey-Wolf Co.
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Ft. Worth, Texas
TA 3-5383(Dallas)

Texas, Ft. Worth

Carey-Wolf Co.
P.O. Box 12425
Ft. Worth, Texas
PE 8-1702

Texas, Houston

Carey-Wolf Co.
P.O. Box 60338
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OL 4-2114

Washington, Seattle

Ray Johnson Co., Inc.
1011 N.E. 69th Street
Seattle 15, Washington
LA 4-5170

Washington, D. C.

Burlingame Assoc., Ltd.
8218 Wisconsin Ave., N.W.
Washington 14, D. C.
OLiver 4-6400

*Local Service Centers.



Our Warranty:

N J E Corp. warrants each power supply manufactured by them to be free from defects in material and workmanship. Our liability under this warranty is limited to servicing or adjusting any instrument returned to the factory for that purpose and to replacing any defective parts thereof, except tubes, semi-conductors and fuses. This warranty is effective for five years after delivery to the original purchaser when the instrument is returned, transportation charges prepaid by the original purchaser, and which upon our examination is disclosed to our satisfaction to be defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at cost. In this case, an estimate will be submitted before the work is started. Written permission must be obtained from the factory, before a supply may be returned for examination.

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Electronic Development & Manufacturing

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